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RESEARCH PAPER

Mulch Application and Plant Spacing Influence on Growth Traits, Pests, Insects and Weeds in Cotton (Gossypium hirsutum L.) Varieties

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A B S T R A C T:

Cotton is a sensitive crop for the agronomic practices. Therefore, in this experiment two levels of wheat straw mulch (0 and 4.2 t ha^{-1}) and two different plant spacing (25 and 35 cm), applied on three cotton varieties; Lachata, Coker 310 and Stoneville 213 which were to investigate growth traits and also controlling of weeds, pests, insects and diseases. Thus, the results showed that Lachata variety required fewest days from planting to 50 % flowering and boll opening that were 57.83 and 145.66 days respectively. While, lowest and highest height of first fruiting branch were recorded by Coker 310 and Stoneville 213 (11.55 and 13.13 cm), respectively. In addition, the interaction of factors also was significantly affected NODF and HFFB such as in V2S1M1 by (68.33 days and 13.73 cm). The treatments applied by wheat straw mulch have more vigorous cotton plants and less infected by weeds, insect, pests and diseases as compared to no mulch. The researchers must conduct more experiments to determine the effect of straw mulch on growth of cotton by using different rates.

KEY WORDS: Cotton; Straw mulch; Plant density; Growth; Disease; Weeds.
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1. INTRODUCTION:

Cotton (*Gossypium hirsutum* L.) is an annual, tropical shrub which belongs to the Malvaceae family. Thought, it is cultivated in the world wide such as Russia, China, and USA are the main producers of cotton (Liu *et al*., 2013). Gotmare *et al*. (2000) reported that there are fifty recognized species of cotton, where only four are grown worldwide, and the residual species grow wild in the tropical and sub-tropical regions. Commonly grown four species are *G. hirsutum*, *G. barbadense*, *G. arboretum* and *G. herbaceum*. Sahito *et al*. (2015) reported that cotton is generally first was cultivated in India, but it still grows wild in various regions in the world. However, cotton can be cultivated only throughout summer season (Tariq *et al*., 2017 and 2018).

Besides, it is called white gold or cash crop in certain places because it generates a lot of returns (Ali *et al*., 2014). Ezuruike and Prieto (2014) informed that the most wanted component of the plant is seeds and fiber that utilized as a raw material in many industries such as edible oil, textile, animal feed and paper as well as medicinal products. Due to its many good properties for example comfort, strengths, retention of color and absorption, fiber of cotton is utilized in various products (Khan *et al*., 2020).

Kazemeini *et al*. (2016) described that cotton plants have an indeterminate growth habit, related to this complexity in growth habit of cotton is sensitive to adverse environmental condition and management practice for example mulching, plant spacing, insect and weed control, etc.

Mulching is simply a protective layer of a material that is spread on top of the soil. Mulches can either be organic such as grass clippings,

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straw, bark chips, and similar materials, or inorganic such as stones, brick chips, and plastic. Both organic and inorganic mulches have numerous benefits. Organic mulches also improve the condition of the soil, prevent erosion, conserving soil moisture, maintain a more even soil temperature and prevent weed growth (McMillen, 2013). Mushtaq *et al*. (2020) described about the residues of allelopathic plants left in the field, either inadvertently or applied by hand in the form of mulch that has the probability of suppressing the intensity of weeds. In addition, most of the allelochemicals released by the decaying plant waste inhibits the growth of weeds.

Zhang *et al.* (2014); Li *et al.* (2020) testified that mulching avoids water vapor and reduce unnecessary evaporation, drip method of irrigation and plastic mulching are favorable technique and economic way for modifying thermal microclimate of the soil and advances water use efficiency. Besides, in this framework evapotranspiration of crops modified beneath plastic mulch in comparison to that of bare soil. Using straw mulch enhances soil moisture storage. On the basis of comments made on the plain and the plateau of Northern China, crop residue mulching improved efficiency of water use by (10 to 20%) due to reduced soil evaporation and increased sweat. In addition, grass mulch has been demonstrated to enhance the efficiency of water use between 1.72 and 1.94 kg m^{-3} for winter wheat (Ji and Unger, 2001; Deng *et al*., 2006). Mulching as a potential method in land management, especially in dry areas that might enhance soil water storage (Zhang *et al*., 2009; Bezborodov *et al*., 2010).

Singh *et al*. (2015) concluded that plant spacing in cotton influences growth and yield of the plant. This can be due to the fact that the production of cotton is said to be partly dependent on crop geometry based on plant and row spacing. Since, proper spacing results in healthy and proper growth of crops. Appropriate spacing promotes flow of air to the plants, resulting in temperature moderation and photosynthesis increases, allows the plants to compete for sunlight, fertilizer and water. As well as, it helps in the inhibition of disease and pests that transfer between plants. Bhalerao *et al*. (2010) found that, the required spacing for cotton, where higher seed yield of 1671 kg ha^{-1} was observed with narrow spacing 60 x 30 cm as compared to wider spacing 60 x 45 cm. Although, growth and yield contributing parameters under wider spacing found to be superior except in height of plant in which the results were reversed.

The aims of the current study were to investigate the impact of wheat straw mulching and plant spacing on growth of different cotton varieties, and their relationship with the pest and weed management in the field.

2.MATERIALS AND METHODS

2.1Materials

Three varieties of cotton (*Gossypium hirsutum* L.) as the plant material were used as shown in (Table 1).

Two levels of mulching by wheat straw were used as M0 with no mulch and M1 by 4.2 t ha^{-1} of mulch. There more, NPK fertilizer was used as basal application in the rate of 150 kg ha^{-1} produced by the SQM company.

Table 1. Information of Cotton varieties were used in the project study

Varieties*	Sources and Origin
Lachata	Spanish, released and recorded in Iraq
Coker 310	American, released and recorded in Iraq
Stoneville 213	American

* Seeds of all the cotton varieties were provided by Assist. Prof. Dr. Rabar Fatah Salih.

2.2 Experimental Design

The study was carried out in the College of Agricultural Engineering Sciences, Salahaddin University-Erbil, which was during summer season at two locations. The first location was in the Grdarasha Field and the second location was in the Research Station of Ainkawa which were in

(12 April and 3 May 2021), respectively. Factorial Randomized Complete Block Design (RCBD) in three replications was practiced. The first factor was two levels of mulching by wheat straw were used as M0 with no mulch and M1 by 4.2 t ha^{-1} added to the plots of sowing day. The second factor was plant spacing (25 and 35 cm) between plants, as symbolled (S_1 and S_2) respectively, while row spacing was 75 cm. Additionally, three varieties of cotton were used as plant material (Lachata, Coker 310 and Stoneville 213) as V1, V2, and V3 respectively which was as the third factor. Three seeds were placed in each hole at the depth of 2-3 cm. Plot size was (3 x 2 m^2), each plot contains of 5 rows, block shape was made rectangular and perpendicular to the direction of the gradient.

2.3Data Collection

2.3.1 Determination of growth traits

2.3.1.1 Number of days from planting to 50% flowering

Number of days to 50 % flowering was counted of each treatment unit (Sedeeq and Rabar, 2011).

2.3.1.2 Number of days from planting to 50% boll opening

Number of days to 50 % boll opening was counted of each treatment unit (Sedeeq and Rabar, 2011).

2.3.1.3 Number of nodes for first fruiting branch

Number of nodes for first fruiting branch was measured from five selected plant of internal rows in each plot randomly and then average was calculated (Akbar *et al*., 2015).

2.3.1.4 Height of first fruiting branch (cm)

Height of first fruiting branch was measured from the five selected plants of internal rows in each plot randomly and then average was calculated (Akbar *et al.*, 2015).

2.3.2 Determination of some cotton plants infected with pests and insects

Cotton as other plants can be contaminated by pests, insects and diseases. Figure 1 shows some cases of cotton plants infected by pests and insects in this current study at different stages of plant growth. For prevent these situations plants were sprayed with insecticides (Yamactin 1.8% EC, Al-Yamama Company, 15 cc/20 L water was used), and also (Mospilan SP., Nippon Soda Co. LTD, 25g/20 L water was used), respectively at two different stages of plant infection. Additionally, wheat straw was used to know its impact of plant infecting by pests and insects.

Figure 1. Cotton plants infected by pests, insects and disease.

2.4 Statistical Analysis

Growth parameters were statistically analyzed according to the technique of analysis of variance (ANOVA) for randomized complete block design, (RCBD) using IBM SPSS Statistics program (20) the mean comparison was fulfilled according to Duncans multiple range test at the level of significant 0.05.

3. RESULTS

3.1 Effect of straw mulch, plant spacing and varieties on growth Traits

Table 2 displays the main comparison of plant growth traits (number of days from planting to 50 % flowering, height of first fruiting branch, number of nodes of first fruiting branch and number of days from planting to 50 % boll opening) at both location. The results indicated that in Grdarasha field all the mentioned growth parameters were none significantly influenced by plant spacing, while significantly influenced by mulching an exception for number of nodes of first fruiting branch which was not significant. As well as, there are significant influence between varieties for the treats of (HFFB, NON and NODBO), in which NODF were not significant. On the other hand, in Ainkawa field the growth parameters were significantly influenced by mulching, the traits for plant spacing were not significant. Varieties significantly influenced (HFFB, NON and NODBO), while NODF were not significance between varieties. However, the interactions of factors like plant spacing, mulching and varieties were significance for all growth parameters except for NON which was non significance. Although, in Ainkawa location the interaction was non significance for growth parameters despite of HFFB which was significance. This was because mulching may enhance growth of cotton, and this might be due to enhancing soil chemical and mechanical properties, also reducing evaporation through improving water use efficiency for the cotton crop.

Table 2. The analysis of variance (ANOVA) for the influence of different growth traits and their interactions at Grdarasha and Ainkawa fields

	Grdarasha field												
		NODF			HFFB			NON			NODBO		
	DF	MS	F.V	P.V	MS	F.V	P.V	MS	F.V	P.V	MS	F.V	P.V
V	2	21.78	2.20	0.13	7.58	7.82	0.00	1.69	7.40	0.00	129.78	11.83	0.00
S	1	20.25	2.05	0.17	0.44	0.46	0.51	0.03	0.12	0.73	13.44	1.23	0.28
M	1	56.25	5.69	0.03	5.76	5.94	0.02	0.00	0.01	0.95	75.11	6.85	0.02
V-S-M	7	54.89	5.55	0.00	4.04	4.16	0.00	0.15	0.65	0.71	26.68	2.43	0.05
						Ainkawa field							
V	2	39.00	8.02	0.00	24.66	13.24	0.00	2.00	6.80	0.01	48.03	6.31	0.01
S	1	0.11	0.23	0.88	0.54	0.29	0.60	0.11	0.37	0.55	12.25	1.61	0.22
M	1	0.11	0.23	0.88	0.36	0.19	0.66	0.11	0.37	0.55	0.03	0.00	0.95
V-S-M	7	1.01	0.21	0.98	5.37	2.88	0.03	0.18	0.59	0.75	2.85	0.38	0.91

V = Variety, S = Spacing and M = Mulching, F. V = F.value and P.V = P value.
NODF = Number of days to 50 % flowering, HFFB = Height of first fruiting branch, NON = Number of nods of first fruiting branch and NODBP = Number of days to 50 % ball opening.

3.2 Effect of mulch, plant spacing and varieties on number of days from planting to 50 % flowering

The results of Grdarasha location indicated that, mulch and interaction treatments were significantly affected NODF. Interaction treatments V2S1M1 required 68.33 days, and V1S2M0 required 78.00 days while V3S1M1 needed 80.00 days for 50 % flowering. This means that application of mulch with 25 cm plant spacing for V2 were better as compared to non-mulched treatments. On the other hand, the results of Ainkawa field showed that V1 was required fewest days from planting to 50 % flowering which was just 57.83 days followed by V2 that needed 58.83 days, while V3 required 61.33 days (Figure 2).

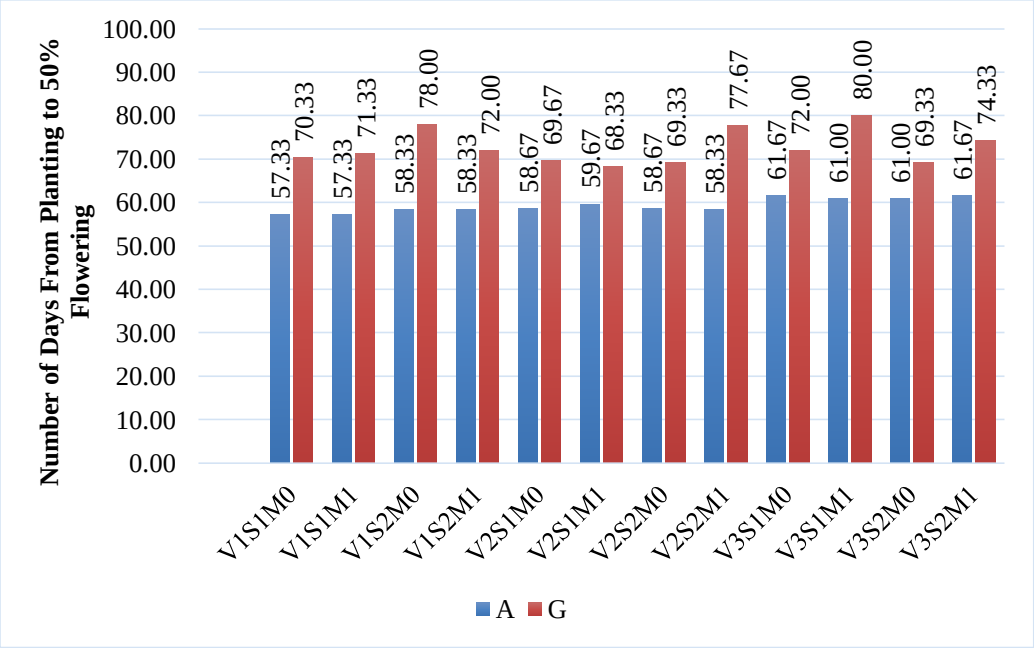

Figure 2. Number of days from planting to 50% flowering for cotton plants at both locations, (A) Ainkawa and (G) Grdarasha fields.

3.3 Effect of mulch, plant spacing and varieties on number of days from planting to 50 % boll opening

Variety, mulching and interaction treatments were significantly affected number of days from planting to 50% boll opening in Grdarasha locution (Table 2). According to the results in figure 3, V1 and V2 that required (145.66 and 145.00 days), respectively there were significance difference compared to V3 was required 151.00 days. This growth parameter was also changed dramatically by interaction among variety, plant spacing and mulching. The lowest value was recorded by 143.66 days in V2S2M0 treatment, while V3S2M1 was recorded 155.66 days. In Ainkawa location variety was again significantly affected (NODBO), V2 needed 127.75 days, while V3 required 131.33 days (Figure 3). There more, plant spacing, mulching and their interaction were non significance and in this situation the superiority goes to the variety so V2 which was better compared to other varieties, since boll maturation period was relationship to that growth parameter which was caused to pick fiber at an appropriate time.

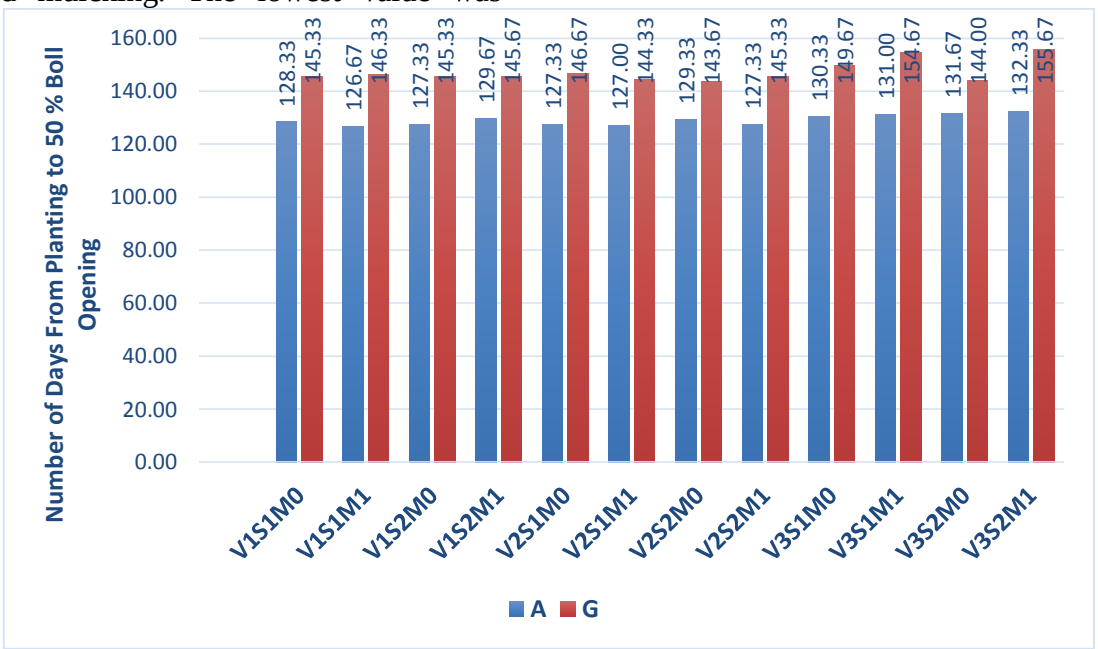

Figure 3. Number of days from planting to 50% boll opening for cotton plants at both locations, (A) Ainkawa and (G) Grdarasha fields.

3.4 Effect of mulch, plant spacing and varieties on number of nodes for first fruiting branch

Number of nodes of first fruiting branch (NON) significantly influenced by varieties at both location, which in Grdarasha V2 and V1 has been recorded 5.55 and 5.58 NON respectively, and V3 recorded 6.21 NON. Although, in Ainkawa V1, V2 and V3 recorded 6.70, 7.11 and 7.51 NON, respectively. Whereas, NON were none significantly influenced for the plant spacing, mulching and the interaction at both sites as showed in (Figure 4).

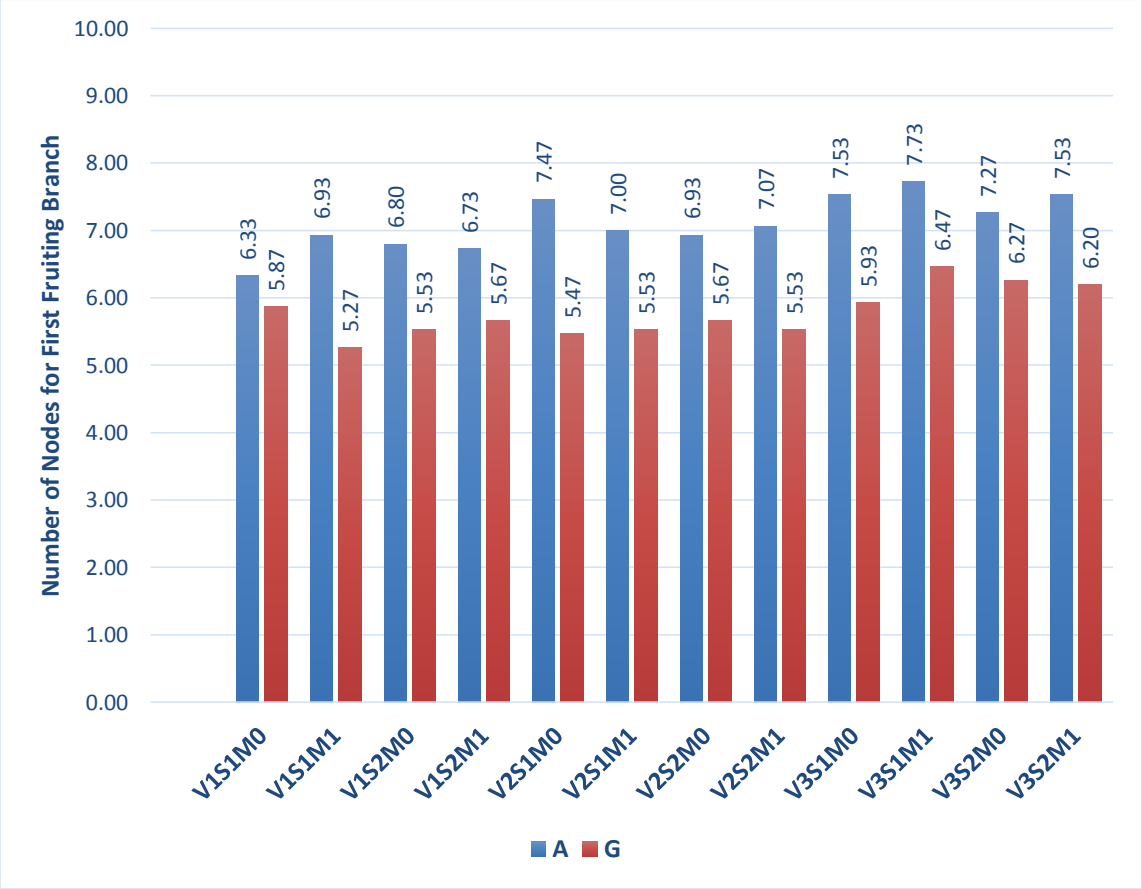

Figure 4. Number of nodes for first fruiting branch in cotton plants at both locations, (A) Ainkawa and (G) Grdarasha fields.

3.5 Effect of mulch, plant spacing and varieties on height of first fruiting branch (cm)

Figure 5. Represented that in Grdarasha field there were significance difference between varieties for HFFB. Lowest HFFB was recorded by V2 that was 11.55 cm, and highest HFFB was 13.13 cm for V3. On the other hand, the mulch and interaction were affected HFFB, V2S1M0 and V3S1M1 recorded (9.60 and 14.73 cm), respectively. However, in Ainkawa V1 and V2 were recorded (15.65 and 16.11 cm), respectively which significant as compared to V3 was recorded (18.33 cm) of HFFB. Plant spacing and mulching not influenced HFFB, but the interaction of factors was significance, lowest fruiting branch was recorded by V2S1M1 that was 13.73 cm, and highest fruiting branch was 19 cm for V3S1M1.

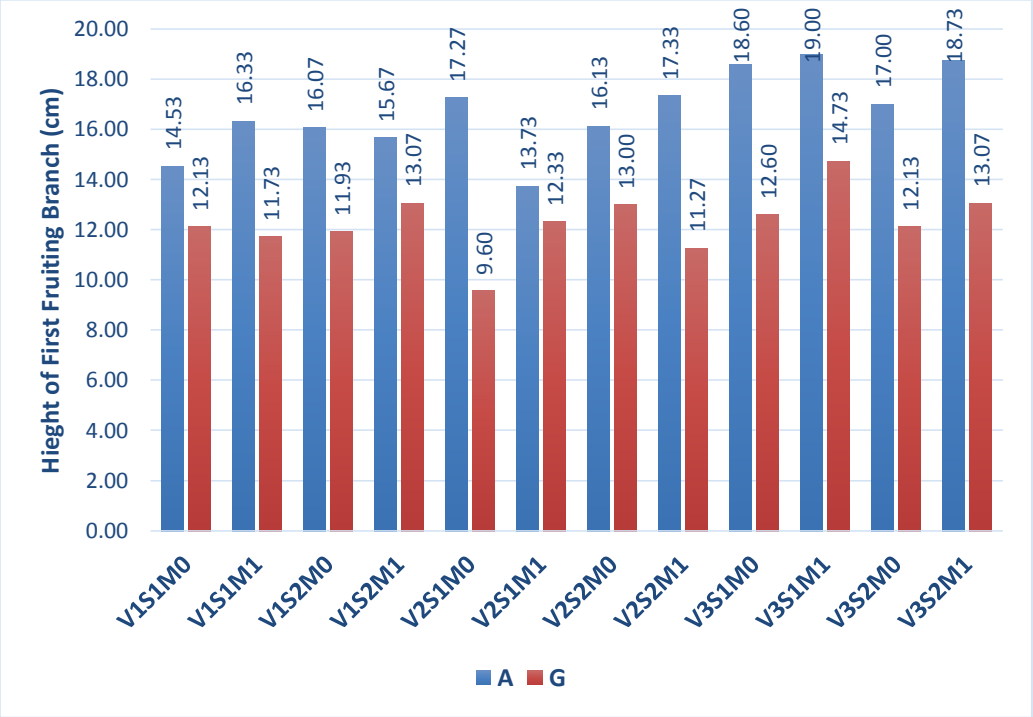

Figure 5. Height of first fruiting branch (cm) for cotton plants at both locations, (A) Ainkawa and (G) Grdarasha fields.

3.6 Effect of straw mulch and plant spacing on healthy growth, pest and disease resistance

Figures (6 and 7) show cotton plants at both location (Ainkawa and Gerdarasha), respectively. Images (a) were mulched plants with wheat straw while images (b) were none mulched plants. Mulched plants were more vigorous and healthier as compared to none mulched plants, due to its moisture retention thereby enhancing soil chemical and physical properties also may not need to use herbicide, fungicide and pesticides. Then it had more resistance against insects, pests and diseases. Additionally, it caused to reduce plants infected by insects and pests as compared to none mulched plots, may leads to enhance growth and increase yield among cotton plants.

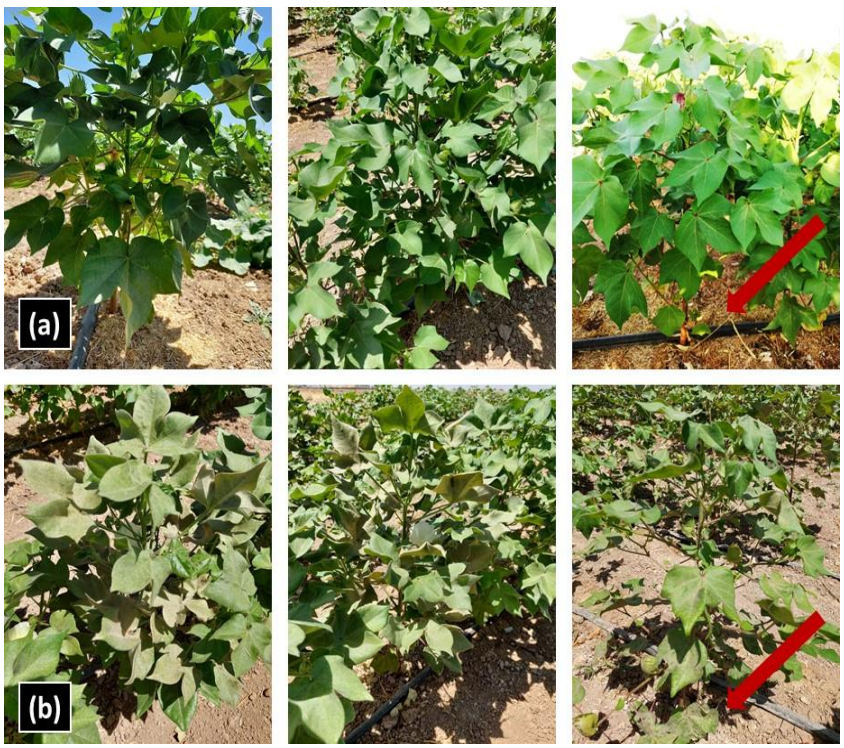

Figure 6. Cotton plants (a) mulched plants; (b) none mulched plants in Ainkawa research station.

Figure 7. Cotton plants (a) mulched plants; (b) none mulched plants in Grdarasha field, College of Agricultural Engineering Sciences, Salahaddin University-Erbil.

3.7 Effect of straw mulch and plant spacing on weed growing

Weeds are major problems in agricultural fields in almost everywhere, and it needs to be reduced or controlled by farmers, because it causes considerable yield losses. As it competes with the main crop for essential sources, such as water, light, space and nutrients. There are several ways to control weeds, for example chemically by using herbicides or physically removing by hand or the use of mulch. During this current study, wheat straw mulch was used which was its affect could be seen in (Figure 8). Weeds were reduced when plants mulched by wheat straw as compared to non-mulched plants (Figure 8a). Weed density in non-mulching treatments was increased and which covered the soil then may cause to stunt growth and lower plant productivity (Figure 8b). In addition, plant spacing also affected weed growth to a considerable extent, the closer plant spacing and quick ground cover, the lesser weed growth as compared to wider spacing.

Figure 8. Straw mulching effects of weed growing (a) plants with straw mulch; (b) plants without mulch.

4. DISCUSSION

The results in this study in accordance with Bezborodov *et al*. (2010) who reported that the use of lower rates of wheat straw such as 1.5 tons ha^{-1} provides a chance for soil sodicity and salinity management, increases yield of cotton and water use efficiency as compared to none mulching, 70 – 85 % of wheat straw can be utilized for other purposes and environmental advantages in terms of soil quality improvement and effective use of existing water resources. Likewise, straw mulch application increased height of the plant, yield and yield components, and better quality of fiber than in none straw mulch. In addition, cotton seed yield and percentage of opened bolls were influenced significantly by straw mulch (Ali *et al*., 2019). Salih (2019) who reported that, minimum and maximum days from planting for 50 % flower opening were required according to the varieties, similarly seeds of Lachata, Coker 310 and Stoneville 213 were sown in three sowing dates. Coker 310 and Stoneville 213 required 124 days when sown in 1st of March, while in 27 of April minimum days was recorded by Lachata and Coker 310 which was just 64 days. Saleem *et al*. (2010) stated that varieties have impacted to the number of days from sowing to first flower emergence. Sadori and CRIS-134 were two cotton varieties characterized as early maturing in order of days to first flower appearance (Baloch *et al.*, 2014). Additionally, as mentioned earlier mulching was also significantly affected that growth parameter in Grdarasha location so which was supported by Dong *et al*. (2007) who reported that, plastic mulch affected number of days for flowering, which in mulched and none mulched treatments flowering required (97 and 103.5 days), respectively. Dong *et al*. (2007) in an investigation showed that plastic mulch reduced the days for boll opening, which needed 142 days as compared to none mulched treatments that were 148.5 days. The same thing was also found in this current study in both location, despite that in some cases mulching was caused to increase number of days might be relation to types of mulch (organic and inorganic). Akbar *et al*. (2015) appeared that plant spacing none significantly influenced number of nodes of first fruiting branch. Parmar *et al*. (2013) who found that the amount of fruit set was considerably better affected by silver on black plastic mulch than no mulched treatments, this may be impacted on a silver-based black mulch by favorable soil temperature, moisture and control of insects, pests and diseases. As well as, Johnson *et al*. (2004) investigated that populations of potato leaf hopper on potato were lower in treatments mulched with straw applied at the time of planting as compared to none mulched or control treatments. Bennett *et al*. (1966) investigated that plastic mulch improved yield of cotton seed by 650 to 975 pounds' $acre^{-1}$, and significantly enlarged the quantity of early

harvested cotton. Dasa *et al*. (2015) informed that rice straw mulching enhanced distribution of soil moisture in comparison to none mulch, lowered the minimum and maximum temperature of the soil as well. Bhardwaj (2013) studied that mulching can control insect pests, and as a result reduced population of whiteflies on grown plants of polyethylene mulch and yellow traps catching the aphids. Ben *et al*. (2009) conducted an experiment by using different colors of films (mulch), and conveyed that the overall number of winged aphids on brown, black and films of clear PE was largely lesser than on white or green films.

Europe and Branco (2018) informed about solarization of soil or heating of soil, which is consisting of a cover of mulch, tarp the soil with a polyethylene transparent sheet throughout the warm season prior to planting the crops. In various regions it was successfully used to prevent or decrease diseases, mites, weeds and other insect pests that carry the soil. Soil solarization employs the suns radiant energy, which is gathered by the polyethylene sheet to warm up the soil to temperatures of (40-55 C) to control the target soil borne pests. Additionally, this current study was also strongly supported by Dvorak *et al*. (2010) reported that phytophthora disease was substantially lower in grass mulched treatments than in control or no mulched, due to optimization of adverse circumstances by a grass mulch in potato haulm. As, a result the vegetative growth and yield parameters influenced by grass mulch as well. Generally, this current study was confirmed by above previous researches. If referring to the figures 6 and 7 there were differences between them visible. Leaves of mulched plants so healthy and its color was dark green that compared to non-mulched plants which was yellow and caused to attract pests and insects. Teasdale and Mohler (2000); Younis *et al*. (2012) reported that residues of plants or crops are supplied to the soil surface for retaining soil moisture, reducing growth of weeds, improving fertility of soil as well as. Germination and seedling growth of weeds restricted by the chemicals released by the process of mulching. Similar results of beneficial effect of using organic mulching were obtained by Cheema and Khaliq (2000); Cheema *et al*. (2004), showed the impact of sorghum mulching such as in maize mulch of sorghum 10 to 15 tons' ha^{-1} reduced weeds by 26-37%, while in cotton mulch with sorghum 3 to 10 tons' ha^{-1} reduced weeds by 23-65%.

Natural control of weeds is achieved by allelopathy, reducing the dangers associated by using synthetic herbicides. Crops that have allelopathic influence like soybean, sorghum, sesame and sunflower has the ability for management of weeds in cotton, such crops may be rotated or intercropped or applied as mulching and incorporation of aqueous extracts can help minimizing weeds pressure. There more, it is possible to limit weed growth in cotton rows by spreading or lifting allelopathic crops between rows of cotton. The herbicides and allelopathic aqueous extracts are effective alone and in combination, one of the examples contains purple nut sedge where the extract of allelopathic sorghum (sorgaab) and a modest dosage of s-metolachlor have been showed 62 – 92 % control (Iqbal and Cheema 2008; Chohan *et al*., 2020). Kazemeini *et al*. (2016) reported about the usage of crop residues that required for covering soil surface for controlling the problems of soil erosion and reduced the probability of weed growth, because of variation in temperature of soil or soil physical properties for weed seedlings. The largest and lowest reductions in weeds were reported when 75 and 25 % of wheat residues were added to the soil sample correspondingly. Results in this current study were in an agreement with many other prelease studies. An investigation pronounced about sorgaab in many cotton researches, which have been shown effectiveness in combination with other herbicides in controlling weeds (Cheema *et al.,* 2003; Iqbal *et al.,* 2009). Dhima *et al*. (2006) investigated that in contrast to none mulched treatments, allelopathic mulches decreased the growth of E. crus galli and S. verticillata. In addition, application of mulch has no influence on maize, grain yield was enhanced by 45 % when barley mulch was added to field of maize as compared to untreated controls. Additionally, this current study was also supported by Nadeem *et al*. (2013) whose conducted an experiment in cotton fields to control weeds, and the results showed that density of all types of weeds was highest when no practice for controlling of weeds was used. It was followed by the treatments when wheat straw mulch used for weed control 30 to 60 days after sowing, although hoeing was used after harvest to remove weeds. Also, results in this present study strongly relative to the results were found by Singh (2009) who reported that straw and farmyard manure mulches were very effective in reducing dry matter of weeds which was showed the impact of

straw mulch as factor to weed control images a and b in figure 4 clearly demonstrated this fact. Sumathi *et al*. (2010) testified that methods of sowing which favors narrow row width and increased population of plants per unit area, decrease available sunlight to weeds resulted in decreased dry mass of emerged weeds later beneath the crop canopy. Quick canopy cover decreases the weed seeds in soil bank, and in order to minimize the establishment of weed seedlings the crops must be sowed in closer rows. Therefore, such conditions will result in successful management of weeds and increased crop yield. The methods of sowing can enhance the competitiveness of crops, decrease weed suppressive capability and consequently enhances productivity of crops. Changes in sowing pattern of cotton may carry changes in time of sowing, plant spacing and plant population, which in turn makes change in the crop plants physiology, microclimate, weed dynamics, pest damage, and damages caused by weeds (Ahmad *et al*., 2009). Finally, farms should be managing through adding mulch based on recommendation and suggestion of research investigations.

5. CONCLUSIONS

According to the results generally the growth traits (NODF, NODBO, NON and HFFB) significantly influenced by varieties, mulching and their interaction, while none significantly influenced by plant spacing. There more, weed growing was reduced or controlled in wheat straw mulched plots as compared to non-mulched plots. As well as, insect, pests and diseases was less affected the growth of cotton in mulched plots as comparison with non-mulched plots. Thereby, using wheat straw mulch has many impacts economically and ecologically.

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Conflict of Interest

The authors declare no conflict of interest.

REFERENCES

Ahmad, N., Arshad, M. and Shahid, M.A., 2009. Bed-furrow system to replace conventional flood irrigation in Pakistan. In *Proceedings of 59th IEC Meeting and 20th ICID Conference held at New Dehli, India from December* (pp. 6-11).

Akbar, H.M., Akram, M., Hassan, M.W., Hussain, M., Rafay, M. and Ahmad, I., 2015. Growth, yield and water use efficiency of cotton (Gossypium hirsutum L.) sown under different planting techniques. *Custos e Agronegocio*, *11*(1), pp.143-160.

Ali, H., Hameed, R.A., Ahmad, S., Shahzad, A.N. and Sarwar, N., 2014. Efficacy of different techniques of nitrogen application on American cotton under semi-arid conditions. *J Food Agric Environ*, *12* (1), pp.157 - 160.

Ali, H., Abbas, A., Hussain, S., Abid, S.A., Khaliq, S. and Sarwar, N., 2019. Mulches and Nitrogen Application Improves Cotton Yield and Fiber Quality. *Journal of Arable Crops and Marketing*, *1*(1), pp.09-13.

Bachheti, A., Sharma, A., Bachheti, R.K., Husen, A. and Pandey, D.P., 2020. Plant allelochemicals and their various applications. *Co-Evolution of Secondary Metabolites*, pp.441-465.

Baloch, M.J., Khan, N.U., Rajput, M.A., Jatoi, W.A., Gul, S., Rind, I.H. and Veesar, N.F., 2014. Yield related morphological measures of short duration cotton genotypes. *J. Anim. Plant Sci*, *24*(4), pp.1198-1211.

Ban, D., Zanic, K., Dumicic, G., Culjak, T.G. and Ban, S.G., 2009. The type of polyethylene mulch impacts vegetative growth, yield, and aphid populations in watermelon production. *Journal of Food Agriculture and Environment*, *7*(3&4), pp.543-550.

Bennett, O.L., Ashley, D.A. and Doss, B.D., 1966. Cotton Responses to Black Plastic Mulch and Irrigation 1. *Agronomy Journal*, *58*(1), pp.57-60.

Bezborodov, G.A., Shadmanov, D.K., Mirhashimov, R.T., Yuldashev, T., Qureshi, A.S., Noble, A.D. and Qadir, M., 2010. Mulching and water quality effects on soil salinity and sodicity dynamics and cotton productivity in Central Asia. *Agriculture, ecosystems & environment*, *138*(1-2), pp.95-102.

Bhalerao, P.D., Patil, B.R., Ghatol, P.U. and Gawande, P.P., 2010. Effect of spacing and fertilizer levels on seed cotton yield under rainfed condition. *Indian Journal of Agricultural Research*, *44*(1), 74-76.

Bhardwaj, R.L., 2013. Effect of mulching on crop production under rainfed condition-a review. *Agricultural Reviews*, *34*(3), pp.188-197.

Cheema, Z.A., Khaliq, A. and Saeed, S., 2004. Weed control in maize (*Zea mays* L.) through sorghum allelopathy. *Journal of Sustainable Agriculture*, *23*(4), pp.73-86.

Cheema, Z.A., Khaliq, A. and Hussain, R.I.A.Z., 2003. Reducing herbicide rate in combination with allelopathic sorgaab for weed control in cotton. *Int. J. Agric. Biol*, *5*(1), pp.1-6.

Cheema, Z.A. and Khaliq, A., 2000. Use of sorghum allelopathic properties to control weeds in irrigated wheat in a semi-arid region of Punjab. *Agriculture, Ecosystems & Environment*, *79*(2-3), pp.105-112.

Chohan, S., Perveen, R., Abid, M., Tahir, M.N. and Sajid, M., 2020. Cotton diseases and their management. In *Cotton production and uses* (pp. 239-270). Springer, Singapore.

Dasa, T.K., Singha, C.B. and Mukhopadhyayb, R., 2015. Effect of straw mulch, irrigation and land configuration on soil hydrothermal regime under Bt cotton (*Gossypium hirsutum* L.).

Deng, X.P., Shan, L., Zhang, H. and Turner, N.C., 2006. Improving agricultural water use efficiency in arid and semiarid areas of China. *Agricultural water management*, *80*(1-3), pp.23-40.

Dhima, K.V., Vasilakoglou, I.B., Eleftherohorinos, I.G. and Lithourgidis, A.S., 2006. Allelopathic potential of winter cereals and their cover crop mulch effect on grass weed suppression and corn development. *Crop science*, *46*(1), pp.345-352.

Dong, H., Li, W., Tang, W., Li, Z. and Zhang, D., 2007. Enhanced plant growth, development and fiber yield of Bt transgenic cotton by an integration of plastic mulching and seedling transplanting. *Industrial Crops and products*, *26*(3), pp.298-306.

Dvorak, P., Tomasek, J. and Hamouz, K., 2010. Cultivation of organic potatoes with the use of mulching materials. *Zeszyty Problemowe Postepow Nauk Rolniczych*, *557*(1), pp.95-102.

Europe, P.A.N. and Branco, I., 2018. Alternative methods in weed management to the use of glyphosate and other herbicides. *Pesticide Action Network Europe. Disponibile all'indirizzo internet: https://www. greensefa. eu/files/doc/docs/ef14a7e5fc8eb8191b3e742610d28 cf2. pdf Pannacci E, Lattanzi B, Tei F (2017). Non-chemical weed management strategies in minor crops: A review. Crop Protection*, *96*, pp.44-58.

Ezuruike, U.F. and Prieto, J.M., 2014. The use of plants in the traditional management of diabetes in Nigeria: Pharmacological and toxicological considerations. *Journal of Ethnopharmacology*, *155*(2), pp.857-924.

Gotmare, V., Singh, P. and Tule, B., 2000. Wild and cultivated species of Cotton. *Technical Bulletin; Central Institute for Cotton Research: Nagpur, India*, *5*.

Iqbal, J. and Cheema, Z.A., 2008. Purple nutsedge (*Cyperus rotundus* L.) management in cotton with combined application of sorgaab and s-metolachlor. *Pak. J. Bot*, *40*(6), pp.2383-2391.

Iqbal, J., Cheema, Z.A. and Mushtaq, M.N., 2009. Allelopathic crop water extracts reduce the herbicide dose for weed control in cotton (*Gossypium hirsutum*). *Int J Agric Biol*, *11*(4), pp.360-366.

Ji, S. and Unger, P.W., 2001. Soil water accumulation under different precipitation, potential evaporation, and straw mulch conditions.

Johnson, J.M., Hough-Goldstein, J.A. and Vangessel, M.J., 2004. Effects of straw mulch on pest insects, predators, and weeds in watermelons and potatoes. *Environmental Entomology*, *33*(6), pp.1632-1643.

Kazemeini, S.A., Moradi Talebbeigi, R. and Valizade, M., 2016. Effect of nitrogen and wheat residue on cotton (*Gossypium hirsutum* L.) yield and weed control. *Archives of Agronomy and Soil Science*, *62*(3), pp.395-412.

Khan, M.A., Wahid, A., Ahmad, M., Tahir, M.T., Ahmed, M., Ahmad, S. and Hasanuzzaman, M., 2020. World cotton production and consumption: An overview. *Cotton production and uses*, pp.1-7.

Li, M., Xiao, J., Bai, Y., Du, Y., Zhang, F., Cheng, H. and Wang, H., 2020. Response mechanism of cotton growth to water and nutrients under drip irrigation with plastic mulch in Southern Xinjiang. *Journal of Sensors*, *2020*.

Liu, C., Yuan, D., Zhang, X. and Lin, Z., 2013. Isolation, characterization and mapping of genes differentially expressed during fibre development between *Gossypium hirsutum* and *G. barbadense* by cDNA-SRAP. *Journal of genetics*, *92*(2), pp.175-181.

McMillen, M., 2013. The effect of mulch type and thickness on the soil surface evaporation rate.

Mushtaq, W., Siddiqui, M.B. and Hakeem, K.R., 2020. *Allelopathy: potential for green agriculture*. Springer Nature.

Nadeem, M.A., Idrees, M., Ayub, M., Tanveer, A. and Mubeen, K., 2013. Effect of different weed control practices and sowing methods on weeds and yield of cotton. *Pakistan Journal of Botany*, *45*(4), pp.1321-1328.

Parmar, H.N., Polara, N.D. and Viradiya, R.R., 2013. Effect of mulching material on growth, yield and quality of watermelon (*Citrullus lanatus* Thunb) Cv. Kiran. *Universal Journal of Agricultural Research*, *1*(2), pp.30-37.

Sahito, A., Baloch, Z.A., Mahar, A., Otho, S.A., Kalhoro, S.A., Ali, A., Kalhoro, F.A., Soomro, R.N. and Ali, F., 2015. Effect of water stress on the growth and yield of cotton crop (*Gossypium hirsutum* L.). *American Journal of Plant Sciences*, *6*(07), p.1027.

Saleem, M.F., Shakeel, A., Bilal, M.F., Shahid, M.Q. and Anjum, S.A., 2010. Effect of different phosphorus levels on earliness and yield of cotton cultivars. *Soil & Environment*, *29*, pp.128-135.

Salih, R.F., 2019. Effect of Sowing Dates and Varieties of Cotton (*Gossypium hirsutum* L.) on Growth and Yield Parameters. *Zanco Journal of Pure and Applied Sciences*, *31*(3), pp.64-70.

Sedeeq, F.A.Q. and Rabar, F.S., 2011. Response of growth, and yield for six genotypes of cotton (*Gossypium hirsutum* L.) to potassium fertilization. *Journal of Kirkuk University for Agricultural Sciences*, *2*(1).

Singh, D.B., Malhi, R.K.M. and Kiran, G.S., 2015. Assessing the impact of agronomic spacing conditions on biophysical and biochemical parameters along with yield and yield components in cotton. *International Journal of Agronomy and Agricultural Research*, *6*(1), pp.6-44.

Singh, G., 2009. Effects of wheat straw and farmyard manure mulches on overcoming crust effect, improving emergence, growth and yield of soybean and reducing dry matter of weeds. *International Journal of Agricultural Research*, *4*(12), pp.418-424.

Sumathi, V., Subramanyam, D., Rao, D.S. and Reddy, D.S., 2010. Effect of planting pattern and weed

management on weed flora and yield of rabi sunflower.

Tariq, M., Afzal, M.N., Muhammad, D., Ahmad, S., Shahzad, A.N., Kiran, A. and Wakeel, A., 2018. Relationship of tissue potassium content with yield and fiber quality components of Bt cotton as influenced by potassium application methods. *Field Crops Research*, *229*, pp.37-43.

Tariq, M., Yasmeen, A., Ahmad, S., Hussain, N., Afzal, M.N. and Hasanuzzaman, M., 2017. Shedding of fruiting structures in cotton: factors, compensation and prevention. *Tropical and Subtropical Agroecosystems*, *20*(2), pp.251-262.

Teasdale, J.R. and Mohler, C.L., 2000. The quantitative relationship between weed emergence and the physical properties of mulches. *Weed Science*, *48*(3), pp.385-392.

Younis, A., Bhatti, M.Z.M., Riaz, A., Tariq, U., Arfan, M., Nadeem, M. and Ahsan, M., 2012. Effect of different types of mulching on growth and flowering of Freesia alba cv.'Aurora'. *Pakistan Journal of Agricultural Sciences*, *49*(4), pp.429-433.

Zhang, S., Lövdahl, L., Grip, H., Tong, Y., Yang, X. and Wang, Q., 2009. Effects of mulching and catch cropping on soil temperature, soil moisture and wheat yield on the Loess Plateau of China. *Soil and Tillage Research*, *102*(1), pp.78-86.

Zhang, Z., Hu, H., Tian, F., Yao, X. and Sivapalan, M., 2014. Groundwater dynamics under water-saving irrigation and implications for sustainable water management in an oasis: Tarim River basin of western China. *Hydrology and Earth System Sciences*, *18*(10), pp.3951-3967.