Agronomic modifications for wheat production in organic farming

PRABHJOT KAUR, GURBAX SINGH and AMANPREET SINGH

Department of Agronomy, Khalsa College, Amritsar

ABSTRACT: A field experiment was conducted during 2015-2016 to find out the effect of agronomic modifications for wheat production in organic farming at Khalsa College Amritsar. The experiment was laid out in a randomized block design with three replications. The treatments consisted of T_1 (Flat planting of wheat i.e. control), T_2 (Bed plating of wheat), T_3 (T_2+intercropping gram in center), T_4 (T_2+intercropping lentil in center), T_5 (Paired row of wheat and gram on bed), T_6 (Paired row of wheat and lentil on bed), T_7 (T_5+straw mulching) and T_8 (T_6+straw mulching). Agronomic modifications related to planting methods, intercropping and mulching significantly affected the plant height, yield attributes, and productivity of wheat crop. Thus, it can be concluded that the agronomic modifications (intercropping and mulching) are an advantageous manipulation for organic farming, especially for staple crops like wheat. The per cent increase in grain yield due to different treatments over control (T_1) was 23.59, 22.18, 21.14, 20.05, 19.72, 19.37, 10.92 in trend $T_7>T_8>T_3>T_4>T_5>T_6>T_2$ respectively.

Key words: Gram, intercropping, lentil, mulching, wheat

Wheat (*Tritium aestivum*) belongs to the Gramineae family and is native to South-West Asia. Adoption of modern crop production technologies but created a problem of land degradation, (Gaillard *et al*., 1997) pesticide residue in farm produce, reduction in soil productivity, soil compaction, depletion of the water table and atmospheric and water pollution due to the dependence on synthetic fertilizers or chemicals. Organic farming is an ecological approach to reduce hazards caused by modern agriculture by developing a natural system of nutrient, water, weed, insect pest, and disease management. Further agronomic innovations that can enhance productivity, conserve resources and reduce weed menace need to explore like bed planting, legume intercropping, straw mulching, irrigation management, crop geometry, etc (Lampkin, 1990). The bed planting system facilitates mechanical cultivation as an alternative method of weed control during the growing season. It also offers the possibility of weeding by hand, an economical option due to the easy entry into the fields as a result of the orientation of the rows of crops in the flower beds, and the management of irrigation water is more efficient, with less labor required with the use of furrows than with conventional flood irrigation (Majeed *et al.,* 2015). Intercropping is traditionally practiced in many parts of the world (Alhaji, 2008) and interest in intercropping with legumes is widespread in temperate regions with warm climates such as the rainy regions of the world (Dhima *et al*., 2007). This is due to its advantages for higher yield, stable yield (which produces a certain yield, even if the cultivation of the components has failed), higher efficiency of land use per unit area, soil conservation and improvement of soil structure, organic content and fertility by adding nitrogen by fixing and excreting the legume component, reducing damage caused by pests, diseases and weeds, resistance to lodging, drying of hay, conservation of forage, high percentage of crude protein and protein yield (Dahmardeh *et al*., 2010). Therefore, an attempt was made to study the effects of agronomic modifications for wheat production in organic farming because the demands for organic products increased day by day in each and every region of the world.

MATERIALS AND METHODS

A field experiment was conducted during winter (Rabi) seasons of 2015-16 at the experimental farm, Khalsa College, Amritsar (31°-38' North latitude, 72°-52 East longitude at an altitude of 236 meters above mean sea level). Soil at the site was sandy loam, neutral in reaction (pH 7.6) and medium in organic carbon (0.5%), and low in available N (180 kg/ha) and high in available P (28 kg/ha) and K (334 kg/ha). Cultivars PBG5 of gram, LL 931for lentil and WH 1105 of wheat were used in this experiment. The treatments consisted of T_1 (Flat planting of wheat i.e. control), T_2 (Bed plating of wheat), T_3 (T_2+intercropping gram in center), T_4 (T_2+intercropping lentil in center), T_5 (Paired row of wheat and gram on bed), T_6 (Paired row of wheat and lentil on bed), T_7 (T_5+straw mulching) and T_8 (T_6+straw mulching). The ANOVA was performed by using a randomized block design with 8 treatments replicated four times. The observed data were then subjected to statistical analysis of variance (Sukhatme and Amble, 1995).

RESULTS AND DISCUSSION

Effect of agronomic modifications on growth

parameters in wheat

Plant emergence, days taken to 50% emergence and days taken for 50% maturity count constitute the very basis of crop physiology which ultimately accounts for crop yield. The data presented in table 1 showed that the above factors did not influence significantly due to different treatments and indicating a uniform crop stand in all the experimental plots. Plant height is an important index of plant development. The perusal of data on periodic plant height in Table 1 indicated that a progressive increase in plant height with the advancement in the age of the crop. The plants observed 10.07,9.16,8.77,8.11,4.02,3.71,2.75 per cent higher plant height with T_8,T_7,T_5,T_6,T_3,T_4,T_2 than T_1. It may be due to uniform distribution of plants and reduction of competition in bed planted, legume intercropped and straw mulched plots which help the plant to use the available resources in a better way because legume intercrop provides nitrogen to crop and straw mulch suppress weed growth. Khan *et al.* (2005) also gave similar results. The perusal of data in Table 1 revealed that the rate of increase in the leaf area index was very slow up to 30 DAS. Among bed and flat planted wheat, bed planted wheat produced higher leaf area index than flat sown wheat at 30, 60 and 90 days of sowing (DAS). Highest value of leaf area index was observed in paired rows of wheat and gram + straw mulch (T_7) which was significantly better than sole wheat (T_2) at 60 DAS onwards and par with paired rows of wheat and lentil + straw mulch (T_8), wheat intercropped with gram and lentil (T_3, T_4) and paired rows of wheat with gram and lentil without straw mulch (T_5, T_6). Similar results were found by Chakraborty (2010). The dry matter accumulation is one of the most important parameters and has a marked influence on the final yield realization of crop. The data in Table 1 showed that bed planted wheat has significantly higher dry matter than flat sown wheat. Further, it was revealed at 60 DAS onwards and harvest that the dry matter accumulation for paired rows of wheat and gram + straw mulch (T_7)which was followed by paired rows of wheat and lentil + mulch (T_8). Treatments T_7, T_8 are significantly better than sole wheat (T_2) and at par with wheat intercropped with gram and lentil (T_3, T_4)and paired rows of wheat with gram and lentil without straw mulch (T_5, T_6). The lowest dry matter accumulation in flat planted wheat (T_1) might be due to more weed competition and less available nutrient fixed by legume intercrop It may be attributed due to proper distribution of plants and better interception of PAR which produced more height of plants, number of tillers and LAI and greater weed suppression. These findings are in line with Quanqi *et al*. (2008).

Effect on agronomic modifications on yield and yield parameters of wheat

Table 1: Effect of agronomic modifications on growth parameters of wheat

Treatments	Emergence count	Days taken to 50% ear emergence	Days taken to 50% maturity	Plant height (cm)				LAI				Dry matter accumulation (g per plant)			
				30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1: Flat planting of Wheat(Control)	89.9	95.4	135.4	16.1	33.8	56.9	75.1	0.4	2.12	3.8	2.92	4.3	17.4	54.4	73
T_2: Bed planting of Wheat	90.4	95.8	135.9	16.5	34.3	58.8	77.7	0.48	2.18	4.22	3.2	4.8	20.1	57.9	77.5
T_3: T_2 + intercropping gram in center	91.2	97.2	136.5	17.7	34.5	59	78	0.52	2.28	4.3	3.28	5.1	21.1	60.8	80.8
T_4: T_2 + intercropping lentil in center	90.9	96.9	136.4	17.4	34.4	58.9	77.8	0.51	2.27	4.29	3.27	5.1	21.1	60.7	80.8
T_5: Paired row Wheat and gram on bed	90.6	96.4	136.3	18.2	36.2	61.8	81.9	0.5	2.26	4.28	3.25	5.1	20.9	60.6	80.7
T_6: Paired row Wheat and lentil on bed	90.4	96.2	136.1	18	36	61.3	81.8	0.49	2.25	4.27	3.24	5.1	20.9	59.9	79.8
T_7: T_5 + straw mulching	91.8	97.4	137.4	18.4	36.5	62.4	82.3	0.54	2.35	4.4	3.34	5.3	21.9	62	82.8
T_8: T_6 + straw mulching	91.6	97.3	137.1	18.4	36.4	62.0	81.9	0.53	2.3	4.32	3.3	5.2	21.7	61.9	81.9
CD (p=0.05)	NS	NS	NS	NS	1.11	2.17	3.62	NS	0.13	0.26	0.19	NS	1.05	2.5	3.34

***** T_7: T_5 + straw mulching means combination of T_5 and straw mulching and same as in case of T_8 treatment

Table 2: Effect of agronomic modifications on yield parameters of wheat

Treatments	Ear length (cm)	Spikelets per spike	Number of grains per ear	Test weight (g)	Grain yield (q ha^{-1})
T_1: Flat planting of Wheat(Control)	9.4	10.4	36.4	34.6	28.4
T_2: Bed planting of Wheat	10.9	11.6	38.9	35.2	31.5
T_3: T_2 + intercropping gram in center	11.3	12.5	39.9	36.8	34.4
T_4: T_2 + intercropping lentil in center	11.2	12.4	39.8	36.6	34.1
T_5: Paired row Wheat and gram on bed	11.1	12.3	39.5	36.5	34.0
T_6: Paired row Wheat and lentil on bed	11.0	12.0	39.2	35.1	33.9
T_7: T_5 + straw mulching	11.6	12.9	40.9	37.3	35.1
T_8: T_6 + straw mulching	11.5	12.8	40.8	37.1	34.7
CD (p=0.05)	0.53	0.63	1.25	NS	2.15

* T_7: T_5 + straw mulching means combination of T_5 and straw mulching and same as in case of T_8 treatment

Table 3: Effect of agronomic modifications on weed dynamics of wheat

Treatments	Weed Count (number of weeds m^{-2})				Weed dry matter (q ha^{-1})			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
T_1: Flat planting of Wheat(Control)	9.4	13.4	12.5	10.8	1.49	3.24	4.42	4.77
T_2: Bed planting of Wheat	9.0	13.0	12.1	9.7	1.30	3.04	4.27	4.61
T_3: T_2 + intercropping gram in center	6.4	8.3	7.4	5.4	0.68	2.33	3.67	4.24
T_4: T_2 + intercropping lentil in center	6.8	8.6	7.8	5.8	0.74	2.36	3.68	4.26
T_5: Paired row Wheat and gram on bed	7.1	7.9	7.3	6.9	0.76	2.38	3.73	4.33
T_6: Paired row Wheat and lentil on bed	7.5	8.0	7.9	7.0	0.77	2.39	3.75	4.35
T_7: T_5 + straw mulching	5.4	8.0	6.8	4.9	0.14	1.72	3.1	3.71
T_8: T_6 + straw mulching	5.8	8.3	6.9	5.0	0.16	1.78	3.09	3.73
CD (p=0.05)	2.45	3.89	3.47	3.03	0.13	0.19	0.16	0.15

* T_7: T_5 + straw mulching means combination of T_5 and straw mulching and same as in case of T_8 treatment

The data presented in Table 2 paired rows of wheat and gram + straw mulch (T_7) which has significantly more spikelet per spike (12.8) than sole wheat (T_2) and at par with paired rows of wheat and lentil + straw mulch (T_8), wheat intercropped with gram and lentil (T_3, T_4) and paired rows of wheat with gram and lentil without straw mulch (T_5, T_6). Flat planted wheat produces a minimum number of spikelets per spike (10.4). The data in tables revealed that the number of spikelets per spike in legume intercropped and straw mulched treatment than sole wheat where legume intercropping and straw mulching is not performed. Dhillon *et al.* (2005) also gave the same result.

The per cent increase in-ear length due to different treatments was recorded 22.87, 22.34, 20.21, 18.62, 18.09, 17.02, 15.96 in trend $T_7>T_8>T_3>T_4>T_5>T_6>T_2$ over T_1. The percent increase in the number of grains per ear due to different treatments over-controlled flat planting (T_1) was 12.37, 12.09, 9.62, 9.44, 8.14, 7.69, 6.59 in trend $T_7>T_8>T_3>T_4>T_5>T_6>T_2$ respectively. The data presented in Table 2 showed that test weight did not influence significantly due to bed planting, legume intercropping and straw mulching. The per cent increase in grain yield due to different treatments over control (T_1) was 23.59, 22.18, 21.14, 20.05, 19.72, 19.37, 10.92 in trend $T_7>T_8>T_3>T_4>T_5>T_6>T_2$ respectively. Treatment, where legume intercropping and straw mulching is not performed, produces less yield because of higher weed competition and no availability of nitrogen whereas it becomes available in legume intercropped and straw mulched treatments. The results were similar to finding of Mandal *et al.* (2014), Khan *et al.* (2005) and Andrews (1979).

Effect of agronomic modification on weed dynamics in wheat

In Table 3, the minimum population and dry matter accumulation of weeds recorded in the bed planted wheat as compared to sole wheat. Paired rows of wheat with gram and lentil + straw mulch (T_7, T_8) had minimum weed populations that differ significantly than controlled flat and bed planting of wheat(T_1, T_2). Among the other treatments, wheat intercropped with gram without straw mulch (T_3) followed by wheat intercropped with lentil without straw mulch showed lower weed population than paired rows of wheat with gram and lentil without straw mulch(T_5, T_6). Ahmed *et al*. (2007) also find similar results.

CONCLUSION

Though, the combined use of mulching and intercropping with wheat results in higher growth and yield, the use of paired rows of wheat and lentil on the bed along with straw mulching can also achieve the yield targets in

addition to other low weed attributes. The percent increase in grain yield due to different treatments over control (T_1) was 23.59, 22.18, 21.14, 20.05, 19.72, 19.37, 10.92 in trend $T_7>T_8>T_3>T_4>T_5>T_6>T_2$ respectively.

REFERENCES

Ahmed I. Z, Ansar M., Iqbal M. and Minhas M. N. (2007). Effect of planting geometry and mulching on moisture conservation, weed control and wheat (*Triticum aestivum* L.) growth under rainfed conditions. *Pak J Bot.,* 39(4): 1189-95.

Alhaji, I.H. (2008).Yield performance of some cowpea varieties under sole and intercropping with maize at Bauchi, Nigeria. *African Research Review,* 2(3), Pp. 278-291.

Andrews D. J. and Kassam A. H. (1979). The importance of multiple cropping in increasing world food supplies. In: Papendick R.I., Sanchez A., Triplett G.B. (eds): Multiple Cropping. ASA Special Publication 27. *American Society of Agronomy,* Madison, Pp 1–10.

Chakraborty D., Garg R. N., Tomar R. K., Singh R., Sharma S. K., Singh R. K., Trivedi S. M., Mittal R. B., Sharma P. K., and Kamble K. H. (2010). Synthetic and organic mulching and nitrogen effect on winter wheat (*Triticum aestivum*) in a semi-arid environment. *Agric Water Mgt*., 97**:** 738-748.

Dahmardeh, M., Ghanbari, A., Syahsar, B. A and Ramrodi, M. (2010). The role of intercropping maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* L.) on yield and soil chemical properties. *African Journal of Agricultural Research*, 5(8): 631-636.

Dhillon S S, Prasher A and Thaman S (2005). Comparative studies on the effect of weed management practices on *Phalaris minor* in bed and conventionally planted wheat (*Triticum aestivum* L). *Indian Journal of Ecology*, 10**:** 72-75.

Dhima, K.V., Lithourgidis, A.A., Vasilakoglou, I.B and Dordas, C.A. (2007). Competition indices of common vetch and cereal intercrops in two seeding ratio. *Field Crop Research*, 100:249-256.

Gaillard G., Hausheer J. and Braun C. (1997). Eco balance of wheat cultivation: comparison between intensive, integrated and organic production. Stoff- und Energiebilanzen in der Landwirtschaft und weitere Beitrage aus den offentlichen Sitzungen, Leipzig, Germany, 15-19 Sept. 1997, Pp. 447-450.

Khan M., Khan R. U., Wahah A., and Rashid A. (2005). Yield and yield component of wheat as influenced by intercropping of chickpea, lentil, and rapeseed in different proportions. *Pak J. Agric Sci.,* 42: 3-4

Lampkin N. (1990). Organic farming, Ipswich, U.K. Farming Press Books, 710p.

Majeed A., Muhmood A., Niaz A., Javid S., Ahmad Z.A., Shah S.S.H., Shah A.H. (2015). Bed planting of wheat (*Triticum aestivum* L.) improves nitrogen use efficiency and grain yield compared to flat planting. *The Crop J.,* 3: 118-124.

Mandal M. K., Banerjee M., Banerjee H., Alipatra A. and Malik G. C. (2014). Productivity of maize based intercropping system during kharif season under red and lateritic tract of west Bengal. *The Bioscan*, 9(1): 31-35.

Quanqi, Yuhai C, Mengyu L, Xunbo Z, Songlie Y and Baodi D (2008). Effects of irrigation and planting pattern on radiation use efficiency and yield of winter wheat in North China. Agric *Water Mgt.,* 98:469-476.

Sukhatame P.V. and Amble V. N. (1995). Statistical Methods for Agricultural Workers. ICAR, New Delhi, Pp. 145-56.

Received: May 30, 2020
Accepted: *July 25, 2020*