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Seeding Density and Seed Steeping Duration Effects on Agro-Morphological Traits of Wheat Relayed at Zero Tillage in Autumn Sunflower

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ABSTRACT

Biological response of wheat relayed in autumn sunflower at zero tillage to different seeding densities and seed soaking durations was studied on a sandy-clay loam soil at the University of Agriculture , Faisalabad. The experiment comprised four seed steeping (soaking) durations, i.e. 0, 6, 12, and 18 hours and four seeding densities, viz.100, 125, 150, and 175 kg ha^{-1} . Standing autumn sunflower crop was flooded to a depth of 7.5 cm. Thereafter, seed of the wheat cv. Inqilab-91 was broadcast in the standing water as per treatments. Interactive effects of seed steeping duration and seeding density on number of spike-bearing tillers m^{-2} and grain yield ha^{-1} were significant. Grain yield increased significantly when wheat was seeded @ 175 kg ha^{-1} using seed soaked in water for 12 hours prior to sowing over all other treatment combinations except that seeded @ 150 kg ha^{-1} with seed soaked for 12 hours. The results suggest that a seed rate of 150-175 kg ha^{-1} along with seed steeping duration of 12 hours can maximize productivity of wheat surface seeded on zero-tilled soil in standing crop of autumn sunflower.

Key Words: Seeding density; Seed steeping; Agro-morphological traits; Zero tillage; Autumn sunflower

INTRODUCTION

Delay in sowing of wheat is the principal cause of its low realized yields in Punjab (Pakistan). Sowing of wheat is delayed due to late harvest of the preceding kharif crops like cotton, rice, maize, sunflower etc and additional time required for intensive cultivation for conventional seedbed preparation. According to an estimate, wheat yields under farmer's condition decline on an average @ 30-40 kg ha^{-1} day^{-1} when planted after 20 November (Anonymous, 1999).

One of the ways to avoid such delay in planting of wheat is to shift from conventional seedbed preparation to surface seeding of wheat on no tilled soil in the standing kharif crop. Such relay cropping of wheat at zero tillage has been reported to produce wheat yields comparable to those obtained from wheat raised on conventionally prepared seedbed (Verma *et al.,* 1989; Akram, 1992). However, two potential problems associated with the relaying surface seeding of wheat at zero tillage are poor plant stand establishment and greater weed infestation. Pre-sowing soaking of the wheat seed can alleviate the former problem. Using above-normal seed rate which ensure desired plant stand can in turn, help suppressing weed growth. This situation warrants optimization of both the seed steeping duration and seeding density to harvest a successful crop of wheat relayed at zero tillage through surface seeding in the preceding sunflower crop. The present study was, therefore, planned to determine the optimum seed steeping duration and seeding density for maximizing productivity of wheat surface seeded on no-tilled soil in the standing crop of autumn sunflower under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

The research was conducted on a medium loam soil under field conditions at the University of Agriculture, Faisalabad. The experiment comprised of four seed steeping durations, i.e. 0, 6, 12 and 18 hours and four seeding densities, *viz.* 100,125, 150 and 175 kg ha^{-1}. Layout design was a randomized complete block with split plot arrangement with four replications and a net plot size measuring 1.8 m x 5 m. Seed steeping duration treatments were allocated to main plots while seeding densities were placed in subplots. Wheat seed was weighed for each experimental unit and completely submerged in water for respective durations as per treatments. Control treatment comprised the dry (unsoaked) seed.

Standing autumn sunflower crop was flooded to a depth of 7.5 cm. Wheat variety Inqilab-91 was sown on 18th of November by surface seeding on no-tilled soil in the flooded plots of sunflower. Fertilizer was applied @ 150-100-50 kg NPK ha^{-1}. All P and K while half of N were applied with first irrigation after sowing of wheat.

The remaining half of N was applied after harvest

of the sunflower stalks. By that time the crop was at tillering stage. Including flood irrigation for sowing of wheat, five irrigations were applied to wheat during its growing period which amounted to 37.8 cm. The amount of water received through rainfall was 3.1 cm. Weed population was kept under the threshold level by using Tribunal-M @ 700 g ha^{-1} after second irrigation which was applied 20 days after sowing of wheat. All other agronomic practices were kept normal and uniform for all the experimental units.

The crop was harvested at its physiological maturity, sun dried and then threshed. Observations on different agro-morphological traits of wheat were recorded by using the standard procedures. Data collected were subjected to the Fisher's analysis of variance technique using Mstat C computer package. Treatment means were compared for significance by using the LSD test at P 0.05 (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Fertile tillers m^{-2}. Seed steeping duration (SSD) did not significantly affect fertile tillers m^{-2}, the grand mean of which was 320 (Table I). Similar number of fertile tillers m^{-2} with different SSD was attributed to the similar total tillers m^{-2}. However, seeding density (SD) had significant effect on number of fertile tillers m^{-2}. Each successive increase in SD caused a significant increment in fertile tillers m^{-2}. A SD of 175 kg ha^{-1} produced the maximum fertile tillers m^{-2} (388) while 100 kg seed ha^{-1} gave the minimum (293).

Interaction of SSD x SD was also significant The maximum fertile tillers m^{-2} (419) were produced by wheat seeded @ 175 kg ha^{-1} without seed soaking. By contrast, crop sown @ 100 kg ha^{-1} with unsoaked seed gave the minimum fertile tillers m^{-2} but was statistically *at par* with the interactions D_3S_1 and D_4S_1.

Spikelets per spike. Pre-sowing SSD did not significantly affect the spikelets $spike^{-1}$(Table I). On the contrary, different SD had significant effect on spikelets $spike^{-1}$. The maximum spikelets $spike^{-1}$ were found in the crop sown @ 175 kg seed ha^{-1} while the mininmum in 125 kg ha^{-1} which did not differ significantly from 100 kg ha^{-1}. Interaction between SSD and SD was non-significant. However, the grand mean of spikelets $spike^{-1}$ was 15.9.

Grains per spike. Various SSD affected grains per spike significantly (Table I). The maximum grains per spike (62.6) was produced by the crop sown with seed soaked in water for 12 hours while the minimum (54.2) with 6 hours SSD. On the contrary, SD had non-significant effect on grains per spike. Similarly interactive effect of SSD and SD on grains per spike was non-significant. However, the grand mean of grains per spike was 58.1.

Table I. Seeding density and seed steeping duration effects on agronomic traits of wheat relayed at zero tillage in autumn sunflower

Treatment	Fertile tillers m^{-2}	Spikelets $spike^{-1}$	Grains $spike^{-1}$	1000-grain weight (g)	Grain yield (kg ha^{-1})	Harvest index (%)
A. Seed steeping duration (hour) [SSD]						
SSD_1 = o	336 ns	15.6 ns	57.4 b	36.4 ns	465 b	40.7 ns
SSD_2 = 6	336	15.6	54.2 c	37.1	4548 d	41.5
SSD_3 = 12	328	16.3	62.6 a	38.8	5227 a	43.4
SSD_4 = 18	326	16.3	57.4 b	38.3	4633 b	42.21
LSD (0.05)			2.3		221	
B. Seeding density (kg ha^{-1})	[SD]					
SD_1 = 100	293 d	15.6 bc	58.2 ns	36.9 b	4771 c	42.7 ns
SD_2 = 125	315 c	15.5 c	59.8	37.4 ab	4653 bc	42.2
SD_3 = 150	330 b	16.0 b	56.9	37.9 a	4903 ab	42.3
SD_4 = 175	388 a	16.7 a	57.8	38.3 a	4930 a	40.6
LSD (0.05)		0.469		0.98	254	
Interaction (SSD x SD)						
SSD_1SD_1	284 h	15.3 ns	56.5 ns	36.8 ns	4445 efg	39.8 ns
SSD_1SD_2	312 ef	15.0	58.3	36.0	4471 defg	40.5
SSD_1SD_3	330 c	16.0	58.0	36.5	4904 bcde	44.4
SSD_1SD_4	419 a	16.3	56.8	36.5	4781 cdef	38.3
SSD_2SD_1	306 fg	15.8	55.5	36.3	4487 defg	41.9
SSD_2SD_2	322 cde	15.3	54.8	37.3	4541 cdefg	44.1
SSD_2SD_3	332 c	15.0	51.8	37.0	4282 fg	40.5
SSD_2SD_4	385 b	16.3	54.8	37.8	4882 cde	39.7
SSD_3SD_1	292 gh	15.8	61.5	37.0	4665 cdefg	45.6
SSD_3SD_2	314 def	16.0	64.8	38.5	4953 bcd	41.0
SSD_3SD_3	330 c	16.3	62.0	39.5	5404 ab	45.2
SSD_3SD_4	377 b	17.0	62.3	40.0	5885 a	41.6
SSD_4SD_1	292 gh	15.5	59.3	37.5	4689 cdef	43.7
SSD_4SD_2	311 ef	15.8	61.3	38.0	4648 cdefg	43.0
SSD_4SD_3	327 cd	16.8	55.8	38.8	5022 bc	39.3
SSD_4SD_4	373 b	17.3	57.3	38.8	4171 g	42.9
LSD (0.05)	13.9				508	

Within a column any two means not sharing the same letter, differ significantly at P = 0.05; ns = Non-significant

1000-grain weight. Pre-sowing SSD did not significantly affect 1000-grain weight (Table I). On the contrary, different seeding densities had significant effect on 1000-grain weight . A SD of 175 kg ha^{-1} caused the maximum increase of 3.6% in 1000-grain weight over standard SD of 100 $kgha^{-1}$ but was statistically on a par with the SD of 125 and 150 kg ha^{-1}. However, SD of 125 kg ha^{-1} was statistically on a par with that of 100 kg ha^{-1}. Interaction between SSD and SD was non-significant. However, the grand mean of 1000-grain weight of wheat was 37.62. Similar results have been reported by Kreft and Spiss (1988).

Grain yield. Grain yield of wheat is a function of the interplay of various yield components (Table I). There were significant differences in wheat grain yield ha^{-1} among different SSD. The maximum grain yield of 5227 kg ha^{-1} was produced by the crop grown from seed soaked for 12 hours. While other three SSD were statistically on a par with one another. Greater grain yield in wheat raised from the seed soaked for 12 hours is ascribed to relatively greater number of grains per spike compared with other SSD.

Different SD also had significant effect on wheat grain yield ha^{-1}. Wheat seeded @ 175 kg ha^{-1} produced the maximum grain yield of 4930 kg ha^{-1} but did not differ significantly from the crop sown @ 150 kg seed ha^{-1}. The latter SD was statistically on a par with 125 kg ha^{-1}. An increase in seeding density from 100 to 125, 150 and 175 kg ha^{-1} increased grain yield of wheat by 6.8, 7.0 and 8.5 per cent, respectively. More grain yield ha^{-1} at elevated seeding densities was primarily attributed to greater number of fertile tillers per unit area and more 1000-grain weight. Interaction between SSD and SD was also significant. The maximum grain yield (5885 kg ha^{-1}) was obtained at SD 175 kg ha^{-1} and SSD of 12 hours which was statistically on a par with SSD_2SD_3. By contrast, crop sown @ 125 kg ha^{-1} of seed soaked for 18 hours produced the minimum grain yield of 4171 kg ha^{-1}. Similar results were reported by Singh and Singh (1984) and Ohlsson (1993).

Harvest index. Neither SSD nor SD or their interaction significantly affected harvest index of wheat (Table I). However, the grand mean of harvest index was 42.

Relationships between development parameters of wheat. There was a highly significant correlation between fertile tillers and total tillers m^{-2} (Table I). Similarly plant height was positively correlated with total tillers m^{-2}. Spike length was positively correlated with grains per spike. Test weight (1000-grain weight) was also positively correlated with spikelets $spike^{-1}$. Similarly there was a positive correlation between biological yield and total tillers m^{-2}. There was also a significant positive correlation between grain yield and plant height, grains $spike^{-1}$, 1000-grain weight or biological yield.

Table II. Simple correlation coefficient (r) values between some development parameters of wheat

Parameter	Correlation coefficient (r) value
Fertile tillers vs total tillers	0.997 **
Plant height vs total tillers	0.548 *
Grains $spike^{-1}$ vs spike length	0.510 *
1000-grain weight vs spikelets $spike^{-1}$	0.704 **
Biological yield vs total tillers	0.601 *
Grain yield vs plant height	0.543 *
Grain yield vs grains $spike^{-1}$	0.509 *
Grain yield vs 1000-grain weight	0.569 *
Grain yield vs biological yield	0.775 *

* = Significant at P = 0.05 , ** = Significant at P = 0.01

CONCLUSIONS

Above information suggests that optimum seed steeping duration and seeding density can significantly improve grain yield of wheat relayed through surface seeding on no-tilled soil in the standing crop of autumn sunflower.

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