Pak. J. Agri. Sci., Vol. 39(1), 2002

INTERSPECIFIC COMPETITION BETWEEN WHEAT *(TRITICUM AESTIVUM* L.) AND GRAM *(CICER ARIETINUML.)*. UNDER BIO-POWER APPLICATION

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To study the interspecific competition between wheat and gram, a pot experiment was conducted. The experiment comprised nine treatments varying in the density of wheat (with or without bio-power inoculation) and gram plants. The interspecific competition significantly influenced the plant height, lOOO-grain weight, grain yield per plant and grain nitrogen content in wheat plants. For gram plants as well, plant height, lOOO-seed weight, seed yield per plant and seed nitrogen content significantly improved as a result of interspecific competition. Nevertheless, intraspecific competition drastically reduced these parameters for both wheat and gram plants grown in monoculture. Yield components of wheat plants raised from seeds inoculated with bio-power and the gram plants competing with them also significantly improved.
Key words: bio-power, gram,. interspecific competition, wheat

INTRODUCTION

Wheat *(Triticum aestivum* L.) is an important cereal crop being used as a staple food in Pakistan. Although the environmental conditions in Pakistan are very conducive for wheat cultivation, its per hectare yield (2166.8 kg) is still less than many agriculturally advanced countries of the world (Anonymous, 2000). A number of factors including insect pest attack, weed infestation, use of poor quality seed, and low soil fertility, may be attributed to this yield gap. Gram *(Cicer arietinumi* , is another most commonly used food item in Pakistan. It is a rich source of protein and carbohydrate with starch being the major component (Bourne, 1989). It is being cultivated over 1089 thousand hectares in Pakistan, but its production too does not fulfill the national requirements (Anonymous, 2000). Use of poor quality seed, insect pest attack, and deficiency in soil moisture and fertility are the main factors attributed to low crop production.

During an interspecific competition, the crop plants normally exert antagonistic effects upon each other for maximum utilization of resources. However, when a leguminous plant is subjected to competition with a non-leguminous plant, the competitive hierarchy is usually altered and the cumulative yield of both crops is expected to increase due to biological nitrogen fixation by leguminous plant resulting in an improvement in soil fertility. Therefore, wheat-gram intercropping has become a common practice in modem agriculture (Mandal et al. 1985). In certain instances legume intercropping has caused substantial improvement in crop production (Willey et al., 1983) that could not be achieved even by using higher rates of chemical fertilizers (Chaudhry et al., 1987).

Nitrogen being a major plant nutrient occupies a conspicuous position in plant metabolism. Many vital processes of plants are associated with proteins because of their nitrogen content.. The deficiency of nitrogen in the cultivated lands therefore, is detrimental to the vegetative and reproductive growth. The arable lands in Pakistan are very deficient in nitrogen. To achieve high crop production, the Pakistani farming community mostly depends upon chemical fertilizers. Chemical fertilizers are not only a heavy burden on our national economy but also, cause many health hazards. The exploitation of microorganisms capable of fixing atmospheric nitrogen therefore, seems a suitable solution of this problem.

The use of effective microorganisms (EM) for the improvement of cultivated crops and for replenishing the soil fertility, is gaining popularity among the agronomists (Carter et al, 1994). Recently, the National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, has introduced a bio-fertilizer named as " bio-power" for improving the wheat crop production. Hence the objective of this study was to examine an interspecific competition between wheat and gram under bio-power application.

MATERIALS AND METHODS

A pot experiment was conducted in the net house of the Botanical Garden, University of Agriculture, Faisalabad during 1999-2000. The experiment comprised nine treatments i. e. T0(100WB:OG), T I(75WB:25G) , T2(50WB:50G), T3(25WB:75G)' T4(OWB: 100G), T5(100WO:OG), T6(75WO:25G)' T7(50WO:50G) and T 8(25WO:75G) varying in the proportional density of wheat and gram plants, with or without bio-power application. Each treatment was replicated four times and the pots were arranged in a completely randomized design with factorial arrangement (Steel and Torrie, 1980). Bio-power was applied to wheat seeds only, as a pre-sowing treatment.. Initially eight wheat grains and eight gram seeds were sown and two weeks after germination, thinning was practised to maintain desired density of wheat and gram plants.

Data about plant height, plant biomass, 1000-grain/ seed weight, grain/ seed yield per plant and nitrogen content of grains and seeds for both wheat and gram crops respectively, were collected and subjected to statistical analysis. Duncan's new multiple range test was applied to compare the treatment means at 95% level of significance (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of interspecific competition between wheat and gram plants under bio-power application on certain yield attributes of wheat are presented in Table I. The maximum plant height (84.93 cm) varying significantly from all other

treatments was recorded for T3 (25WB:75G)' It was followed by T2 (50WB:50G) which had equal proportion of. wheat and gram plants. However, it did not differ significantly from T I (75WB:25G)' TO (wheat monoculture inoculated with bio-power) and T8 (25WO:75G)' Minimum plant height (69.71 cm) was recorded for T5 (IOOWO:OG)' As such plant height gradually decreased with the increasing wheat plant density perhaps due to strong intraspecific competition. These results corroborate the findings of Bulson et al., (1997).

Significantly higher 1000-grain weight than all other treatments was recorded for T3 (25WB:75G i)· In TI(75WB:25G) and T2(50WB:50G) as well, significantly higher 1000- grain weight than pure wheat stand inoculated with bio-power (OWB:OG) was recorded but they differed non-significantly from each other.. Among the uninoculated treatments, the maximum IOOO-grain weight (55.29 g) was obtained for T8(25WO:75G)' that had the lowest density of wheat plants. It may be attributed to the low interspecific competition. The grain weight also gradually decreased as the density of wheat plants increased in T7 and T6· Nonetheless. the least 1000-grain weight was recorded for T5 (I OOWO:OG) perhaps due to strong intraspecific competition among wheat plants. Similar results have been reported by Khan and Saeed (1987) and Mandal et al. (1986).

The maximum grain yield per plant differing significantly from all other treatments except T2(50WB:50Ci), and T I(75WB:25G) was recorded for T3(25WB:75G)' In TO (pure inoculated wheat stand) as well, grain yield per plant was significantly higher than all other treatments which were not inoculated with bio-power.. Grain yield per plant in T8(5WO:75G)' T7(25WO:75G and T6(25WO:75G) was significantly higher than their corresponding pure wheat stands without bio-power inoculation (25WO:75G) but they did not differ significantly among themselves. It seems that the increasing density of wheat plants gradually resulted in lower plant height, IOOO-grain weight and grain yield. However, wheat plants inoculated with bio-power, showed better results than un-inoculated ones.

All the treatments receiving bio-power inoculation (TO, T I, T2 & T3) had significantly higher nitrogen content than those not inoculated with bio-power (T5' T6' T7, & T8), despite the non-significant differences among themselves. Therefore, nitrogen content of wheat grain does not seem to be influenced by the variation in plant density.

In short the increasing density of wheat plants gradually reduced plant height, 1000-grain weight and grain yield per plant perhaps due to strong intraspecific competition among wheat plants and weak interspecific competition between wheat and gram plants. Bio-power inoculation also substantially improved different yield parameters as well as grain nitrogen content of treated plants.

The effect of bio-power and interspecific competition between wheat and gram on some yield attributes of gram are presented in Table 2. The maximum gram plant height was recorded for T4(gram monoculture). It differed non-significantly from T2(50WB:50G) and T3(:~5WB:75G)' Plant height in TI(75WB:25G) and T8(25WO:75G) differing non- significantly from each other was recorded as 37.47 cm and 37.15 Cm respectively. The minimum plant height in T6(75WO:25G) was at par with that recorded for T7(50WO:50G)'

The maximum 1000-seed weight was recorded for T4(OWB: IOOG) which differed significantly from all other· treatments except T3(25WB:75G)' The differences among Tl(IOOWB:OG), T2(50WB:50G), T3(25WB:75G) and T8(25WO:75G) were not significant.. Nonetheless, the minimum 1000-seed weight was examined for T6(75WO:25G) where the gram plants had to compete with 75% wheat plants without bio-power inoculation. Gram seed yield per plant showed a gradual reduction with the increasing density of wheat plants. The maximum seed yield per plant in T4(OWB:I OOG) did not differ significantly from that recorded for T2(50WB:50G) and T3(25WB:75G)' Seed yield per plant in T6(75WO:25G), T7(50WO:50G) and T8(25WO:75G) also did not exhibit significant differences. However, all the inoculated treatments differed significantly from the treatments without bio-power inoculation. except T8(25WO:75G)' Similar results have been reported by Carter et al. (1994).

The nitrogen content of gram seeds does not seem significantly influenced by the increasing density of wheat plants. Gram plants engaged in competition with inoculated wheat plants had significantly higher nitrogen content than those competing with wheat plants raised from wheat grains without bio-power inoculation. However. neither the inoculated wheat plants nor those without bio-power inoculation in different treatments varied among themselves significantly in respect of their nitrogen content..

At higher wheat plant density, a gradual increase in the intensity of interspecific competition between wheat and gram plants may be attributed to a simultaneous reduction in the plant height, 1000-seed weight and seed yield per plant. Similar results have been reported by Bulson et al. (1997).

The results of the present study suggest that for sustainable agriculture and for the improvement of soil fertility especially the soil nitrogen content, establishment of an intercropping agro-ecosytem involving a legume and a non-legume crop seems an effective strategy.

Table 1. Effect of bio-power and interspecific competition between wheat and Uram on some yield attributes of wheat

Treatment	Wheat-gram plant density ratio	Plant height (cm)	IOOO-grainweight (g)	Grain yield/plant -(g)	Grain nitrogen content (%)
To	100WB:OG	78.50 bc*	56.20 c	25.15b	4.00 ab
TI	75WB:25G	80.18 b	58.17 b	26.33 ab	4.30 a
T2	50WB:50G	81.33 b	59.56 b	26.67 a	4.61 a
T3	25WB:75G	84.93 a	62.22 a	27.15 a	4.95 a
T4	°WB:IOOG	-	-	-	0.00
T5	100WO:OG	73.71 d	50.32 c	23.13 c	2.90 c
T6	75WO:25G	75.60 d	51.48 c	24.06 c	3.20 be
T7	50WO:50G	76.53 cd	52.50 c	24.56 c	3.59 b
T8	25WO:75G	78.33 be	55.29 c	25.04 c	3.95 b

WB: wheat seeds inoculated with bio-power, WO: wheat seeds without bio-power inoculation, G: gram, *: Treatment means sharing the same letter differ non-significantly,
-: No wheat plant..

Table 2. Effect of interspecific competition and bio-power on some morphological and yield attributes of gram

Treatment	Wheat-gram plant density ratio	Plant height (cm)	1000-seed weight (g)	Seed yield/ plant (g)	Seed nitrogen content (%)
To	$100_{WB}:0_G$	-	-	-	-
TI	$75_{WB}:25_G$	37.47 b*	228.10 b	32.00 b	6.54 a
T2	$50_{WB}:50_G$	37.53 b	229.45 b	33.30 ab	6.59 a
T_3	$25_{WB}:75_G$	39.90 a	231.58 ab	34.90 a	6.90 a
T4	$0_{WB}:100_G$	40.87 a	236.30 a	35.38 a	7.19 a
T5	$100_{W0}:0_G$	0.00	0.00	0.00	0.00
T6	$75_{W0}:25_G$	35.21 c	219.25 c	28.98 c	4.97 b
T_7	$50_{W0}:50_G$	35.25 c	226.50 c	30.11 c	5.56 b
T_8	$25_{W0}:75_G$	37.15 b	227.00 bc	31.90 bc	5.65 b

WB: wheat seeds inoculated with bio-power; WO: wheat seeds without bio-power inoculation, *: Treatment means sharing the same letters differ non-significantly.

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