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WEED CONTROL EFFICIENCY OF INTERCROPPING LEGUMES IN MAIZE

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ABSTRACT

An experiment entitled "Weed control efficiency of intercropping legume in maize" was conducted at New Developmental Farm, Agricultural University Peshawar during Kharif 2009. The experiment was laid out in randomized complete block design with three replications comprising of 13 different treatments viz; Maize+1 row and with 2 rows of soybean simultaneously seeded, Maize+1 row of soybean delayed seeding by 3 weeks, Maize+ 2 rows of soybean delayed seeding by 3 weeks, Maize+1 row of mungbean and, Maize+2 rows of mungbean simultaneously seeded and Maize+1 row of mungbean delayed seeding by 3 weeks, Maize+ 2 rows of mungbean delayed seeding by 3 weeks. Remaining five treatments were three control treatments (sole maize) viz; an unweeded, a hand weeded and one with herbicide use for weed control, along with sole treatments of mungbean and soybean each. Our findings showed that weed density m^{-2} and biological yield of maize were significantly affected by intercropping of both mungbean and soybean seeded in one-one and two-two rows simultaneously seeded and delayed seeded by three weeks. In case of legume crops pods plant^{-1} and biological yield of mungbean as well as soybean were significantly affected by maize intercropping with mungbean and soybean seeded in one-one and two-two rows simultaneously and delayed seeded by three weeks. Weeds density m^{-2} was significantly reduced by hand weeding and maize-mungbean simultaneous seeding in two rows as compared to weedy check and sole maize with herbicide use. In case of maize, maximum biological yield was recorded in hand weeded plots, followed by maize intercropped with 1 row of soybean seeded 3 weeks later. Higher number of pods plant^{-1} were recorded in plots where sole mungbean was sown, followed by plots where maize was intercropped with one row of mungbean simultaneously seeded. Greater biological yield of mungbean was produced by sole mungbean treatments followed by plots where maize was intercropped with one row of mungbean seeded simultaneously. Higher number of pods plant^{-1} was observed when soybean was grown alone. It was concluded that maize intercropping with mungbean and soybean is useful for efficient land use without affecting maize yield and also providing additional yield of mungbean. Thus intercropping of legumes in maize should be encouraged in the maize growing belt under agro-climatic condition of Peshawar.

Keywords: Intercropping, legume, maize, weeds.

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INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal crop of the world after wheat and rice. Casual natural hazards such as excessive rainfall prolong drought, wind and hail storm may prove extremely harmful for maize in monocrop situation. To avoid the environmental and market risks, particularly small farmers of the country need to have an advance system of maize production. Development of proper intercrop system is one of the best approaches to improve the profitability of the small scale farming. The identification of profitable intercropping system is of particular interest to the farmers of Pakistan where the land holding is decreasing. Intercropping offers to farmers the opportunity to engage nature's principle of diversity at their farms. Spatial arrangements of plants, planting rates and maturity dates must be considered when planning intercrops (Ghosh, 2004). Pest management benefits can also be realized from intercropping due to increased diversity. Multiple cropping systems are also prevalent in many parts of the world and farmers in the temperate region have used alternating strips of corn and soybeans (Sullivan, 2003).

Several researchers have addressed the importance of intercropping however, in Pakistan very few such studies are found which investigate the efficient use of resources, economics, weed control and soil fertility in intercropping. Iqbal *et al.* (2007) reported that intercropping of soybean in sesame and sorghum in cotton significantly decreased the biomass and density of the weeds and increased net return. Malik *et al*. (2008) reported that wild radish and rye cover crops without herbicides reduced total weed density by 35 and 50%, respectively.

In intercropping, weed density and biomass is often markedly reduced compared to the sole cropping (Henrik *et al*., 2003). Therefore the main purpose of this study was to determine the yield and performance of few selected maize legume (mungbean and soybean) intercrop combinations, and to evaluate optimum intercrop system for the field performance, weed control and profitability in order to achieve the objectives to examine the effects of seeding dates (simultaneous with maize or three weeks later) and number of the rows of mungbean and soybean (one or two) seeded between maize rows, on the weeds; to inquire the impact of intercropping and weed control on the total yield of the crop; and to investigate the impact of legume intercropping on fertility status of the soil.

MATERIALS AND METHODS

An experiment was conducted at Agricultural Research Farm, KPK Agricultural University Peshawar during Kharif 2009. The experiment was laid out in randomized complete block design with three replications comprising 13 treatments. The treatments detail is as under;

Treatment	Cropping system	Description
Mungbean	Sole crop	Mungbean with herbicidal weed control
Soybean	Sole crop	Soybean with herbicidal weed control
Maize	Sole crop	Maize with herbicidal weed control
MS1S	Intercrop	Maize+1 row of soybean simultaneously seeded
MS2S	Intercrop	Maize+2 rows of soybean simultaneously seeded
MS1D	Intercrop	Maize+1 row of soybean delayed seeding by 3 weeks
MS2D	Intercrop	Maize +2 soybean rows delayed seeding by 3 weeks
MM1S	Intercrop	Maize+1 row of mungbean simultaneously seeded
MM2S	Intercrop	Maize + 2 rows of mungbean simultaneously seeded
MM1D	Intercrop	Maize +1 mungbean row delayed seeding by 3 weeks
MM2D	Intercrop	Maize+2 mungbean rows delayed seeding by 3 weeks
MWeed	Monocrop	Maize – unweeded con trol
MHand	Monocrop	Maize – hand weeded control

Field previously cultivated with wheat was irrigated, ploughed and then was levelled at proper moisture. Maize variety "Azam" was planted by using the drill. Recommended dose of nitrogen and phosphorus (100 N and 60 P) kg ha^{-1} was applied. Full P and half N was applied at sowing and the remaining N after emergence of the legume crops. Intercropped treatments did not receive extra fertilizer dose as it is believed that leguminous crops produce enough nitrogen to compensate. Each plot consisted of four maize rows, 75 cm apart and 5 m long. In intercrop plots, one/two rows of soybean and mungbean were planted by hand seeder simultaneously or with inter cultivation in maize rows as per treatment description.

The plant population of maize was maintained at 60,000 plants ha^{-1} while the seed rates for soybean and mungbean was 12 kg ha^{-1} each. In herbicide treatment, Primextra Gold 720 SC (s-metolachlor + atrazine) was applied as pre-emergence in maize while Treflan EC was applied as pre-emergence in soybean and mungbean. In hand weeded control (MHand) hand weeding was done. Plots were irrigated as per requirements.

RESULTS AND DISCUSSION

Weed density (m^{-2})

Data regarding weed density m^{-2} are shown in Table-1. Statistical analysis of the data revealed that maize intercropping with soybean and mungbean in different combinations significantly affected weed density (m^{-2}). Mean values of the data indicated that maximum number of weeds (166.3 m^{-2}) were recorded in control (weedy check) plots followed by plots where maize was intercropped with one row of mungbean seeded simultaneously (136 m^{-2}) which was statistically at same level with all treatments except maize hand weeded (45 m^{-2}), sole maize (83 m^{-2}) and maize intercropped with two rows of mungbean simultaneously seeded in which lower number of weeds were recorded. The results indicated that intercropping suppressed the weeds to flourish probably due to competition. As legume crops were broadleaf hence captured the space therefore the weeds beneath were shaded and prevented the sunlight to reach to the weeds. Researchers (Coultas *et al.*, 1996; Buchler *et al.*, 2001; Ghosheh *et al*., 2005) clearly demonstrated beneficial effects of maize–legume intercrops on weed suppression and crop growth. We were expecting that delayed seeding of legume in maize will kill the existing weeds due to tillage and thus weed density will be decreased. Although weed density was decreased at that time due to mechanical cultivation but soon after the cultivation new weeds were germinated and thus there was small difference in the weed density among the treatments. Thus it could be inferred from the results that weeds germination could not be affected by intercropping. However the growth of weeds could be affected by intercropping legume with maize. Lower density in intercropped plots indicated that sole crop cannot suppress the weeds growth as compared to intercropped plots.

Kernels cob^{-1}

Analysis of the data indicated that number of kernels cob^{-1} of maize was non-significantly affected by different treatments (Table-1). The non-significant treatment effects may be the trait under reference being genetically controlled with little effect of environmental factors. Therefore, the treatments had a slight effect on the number of kernels cob^{-1}. However more number of kernels cob^{-1} (303.7) was recorded in hand weeded plots. This greater number of kernels cob^{-1} is because of no competition with weeds as weeds were mostly controlled in these plots which made the resources available for the crop plants that ultimately resulted in more number of kernels cob^{-1}. Minimum number of kernels cob^{-1} (273.7) were recorded in plots where maize was planted as sole crop and herbicide was applied (Table 1) for weed control. Due to the severe competition by the weeds even herbicide was used but herbicide could not control all the weeds which resulted in lower number of kernels cob^{-1} as compared to hand weeding. In the absence of intercropping there were enough niches available to the weeds to flourish and compete with the crop plants. Our results are in line with Zaman and Malik (2000), who found that number of kernels cob^{-1} was not significantly affected by intercropping. However, Karamallah (1989) reported that reduction in kernels cob^{-1} of maize in intercropping may be due to the plants competition for nutrients and mutual shading effect due to closer space among the plants.

Biological yield (kg ha^{-1}) of maize

Data regarding biological yield of maize are shown in Table-1. Analysis of the data revealed that biological yield of maize was significantly affected by maize intercropping with one and two rows of soybean and mungbean both seeded simultaneously and delayed sowing by three weeks. Mean values indicated that maximum biological yield (7555 kg ha^{-1}) was recorded in hand weeded plots, followed by maize intercropped with one row of soybean seeded 3 weeks later (6389 kg ha^{-1}), which was statistically at par with each other, whereas low biological yield (3596 kg ha^{-1}) was produced in weed check, however it was statistically at par with all other treatments except the two top scoring treatments. It might be due to heavy infestation of weeds in weedy check plots which ultimately decreased biological yield of maize. The weeds reduced maize vegetative growth and grain yield. The results are in line with Ennin *et al.* (2002), who found close association of soybean and maize and reported that soybean and maize may be planted as intercrops in alternating single rows to take advantage of available solar radiation and greater dry matter yields. High biological yield is an indicator of crop growth. However, sometime, due to severe weed competition, maize plants fail to produce harvestable ears (grain bearing ears). The potential of higher biological yield of a crop is an indicator of effective weed suppression in maize; there is an inverse relationship between biological yield of maize and weed biomass.

Table-1. Weed density (m^{-2}), kernels cob^{-1}, and biological yield (kg ha^{-1}) of maize as affected by inter-cropping maize with soybean and mungbean.

Treatment	Weed density (m^{-2})	Kernels cob^{-1}	Biological yield (Kg ha^{-1})
Maize	83 fg	273.7	5244 bc
MS1S	120 bc	290.0	4051 c
MS2S	111 b-e	288.7	4388 bc
MS1D	115 b-d	294.0	6389 ab
MS2D	104 c-f	287.0	4207 c
MM1S	136 b	287.3	3972 c
MM2S	72 g	299.0	5402 bc
MM1D	96 c-g	292.3	5318 bc
MM2D	93 d-g	296.3	4011 c
MWeed	166 a	277.3	3596 c
MHand	45 h	303.7	7555 a
$LSD_{0.05}$	27	NS	2109

Means in each columns followed by different letters are significantly different from each other by LSD at $p \leq 0.05$.

Number of pods plant^{-1} of mungbean

Data regarding number of pods plant^{-1} are shown in Table-2. Perusal of the data indicated that intercropping of mungbean with maize in different combinations significantly affected pods plant^{-1}. More number of pods plant^{-1} (15.64) were recorded in plots where sole mungbean was sown, followed by plots where maize was intercropped with one row of mungbean simultaneously seeded (11.37), which was however at par with the rest of the intercropping treatments. The absence of both the intra and inter specific competition in the sole mungbean treatment triggered the supply of photosynthates towards the economic yield of the crop including the number of pods plant^{-1}. The results are in line with Subramaniam and Maheswari (1992), who reported variation in the number of pods by various intercropping practices. Similarly, Polthanee and Trelo-ges (2003) reported that the pod number plant^{-1} was affected by intercropping. Zaman and Malik (2000) also reported maximum rice bean pods plant^{-1} in sole treatment. Number of pods plant^{-1} is an important yield component and greatly affects the economic yield. The instant results suggest that delaying mungbean sowing decreased the pod formation in intercropped maize. Although delayed sowing suppressed the weeds due to inter-cultivation but the grain yield of mungbean is decreased due to lesser number of pods plant^{-1}. Therefore delayed planting of legume in maize is discouraged in intercropping system. Khan *et al*. (2011) have also worked on mungbeans.

Biological yield (kg ha^{-1}) of mungbean

Statistical analysis of the data revealed that the effect of maize intercropping with mungbean in different combinations was significant on biological yield of mungbean (Table-2). Mean values indicated that higher biological yield was produced by sole mungbean (1544 kg ha^{-1}), followed by plots where maize was intercropped with one row of mungbean seeded simultaneously (1333 kg ha^{-1}). These were however, statistically similar with each other. This higher biological yield in sole mungbean might be due to the fact that mungbean crop used full solar radiation for efficient photosynthesis that resulted in more vegetative growth and plant height which ultimately resulted in higher biological yield as compared to the intercropping. In addition, mungbean crop in sole treatment passed through the intraspecific competition, as a result gained higher biological yield. Minimum biological yield (1083 kg ha^{-1}) was obtained in plots where maize was intercropped with two rows of mungbean simultaneously seeded. However, it was at par with all intercropped treatments. It might be attributed to the higher density of the both crops (maize and mungbean) that competed for the solar radiation, nutrients, water etc. Shortage of such factors stressed mungbean crop in two- two row combination to give lesser biological yield. Moisture stress and shading are among the factors that severely affect crop yields at different growth stages.

Table-2. Pods plant^{-1} and biological yield of mungbean as affected by intercropping.

Treatments	Pods plant^{-1}	Biological yield (kg ha^{-1})
Mungbean	15.64 a	1544 a
MM1S	11.37 b	1333 ab
MM2S	09.32 b	1083 b
MM1D	08.29 b	1132 b
MM2D	08.76 b	1264 b
$LSD_{0.05}$	3.82	257.8

Means in each columns followed by different letters are significantly different from each other by LSD at $p \leq 0.05$.

Number of pods plant^{-1} of soybean

Data on pods plant^{-1} are given in Table-3. Perusal of the data revealed that intercropping of soybean with maize in different combinations significantly affected pods plant^{-1}. Higher number of pods plant^{-1} (141.33) were recorded in plots where soybean was grown alone, followed by plots where maize was intercropped with one row of soybean simultaneously seeded (118.33), whereas lower pods plant^{-1}(43.67) were recorded in plots where maize was intercropped with two rows of soybean delayed seeded by three weeks. The reduction in pod yield by intercropping could be due to interspecific competition and depressive effect of maize. Crops with C4 photosynthetic pathways such as maize have been known to be dominant when intercropped with C3 crops like soybean (Hiebsch *et al*., 1995). Reduction in number of pods due to intercropping has also been reported by Galal *et al.* (1979) who intercropped soybean in maize. Ndakidemi and Dakora (2007) reported reduction in cowpeas number of pods per plant under intercropping as compared to the sole cropping. Soybean is not cultivated in the area under discussion while mungbean is widely cultivated in the area. Therefore mungbean intercropping in maize is recommended for the farmers.

Biological yield (kg ha^{-1}) of soybean

Data pertaining to biological yield of soybean are shown in Table-3. Analysis of the data indicated that biological yield of soybean was significantly affected by intercropping soybean with different combinations of maize. Maximum biological yield was recorded in soybean alone (5056 kg ha^{-1}) followed by plots where maize was intercropped with two rows of soybean seeded simultaneously (3833 kg ha^{-1}). However, it was at par with all other intercropping treatments. The lower biological yield in intercropped plots could be due to the shading effect of maize and also due to the competition between maize and soybean for moisture, nutrients and other resources which resulted in decline in biological yield.

Table-3. Pods plant^{-1} and biological yield of soybean as affected by intercropping.

Treatments	Pods plant^{-1}	Biological yield (kg ha^{-1})
Soybean	141.33 a	5056 a
MS1S	118.33 b	3500 b
MS2S	067.67 c	3833 b
MS1D	051.33 cd	3600 b
MS2D	043.67 d	3428 b
$LSD_{0.05}$	**18.20**	**992.9**

Means in each columns followed by different letters are significantly different from each other by LSD at $p \leq 0.05$.

CONCLUSION

Intercropping of both mungbean and soybean had a significant effect on suppressing the weed density and improving the biological yield of maize in all the treatments. On the other hand, pods plant^{-1} and biological yield of mungbean as well as soybean were also convincingly affected by the intercropping of maize with them. The biological yield of maize was the highest in hand weeded treatments, followed by maize intercropped with one row of soybean seeded 3 weeks later. Greater biological yield of mungbean was produced in sole mungbean plots followed by plots where maize was intercropped with one row of mungbean seeded simultaneously. For soybean, higher number of pods plant^{-1} was observed when soybean was grown alone. Therefore, maize intercropping with mungbean and soybean is useful for efficient land use without affecting maize yield and also providing additional yield of mungbean. Intercropping of legumes in maize should be encouraged in the maize growing belt under agro-climatic condition of Peshawar.

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