Intercropping of chick pea and mustard on control of botrytis grey mold in western Terai, Nepal

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Abstract

Integrated management strategies are required to minimize botrytis grey mold disease of chickpea (Cicer arietinum L.) caused by Botrytis cinerea. This study was undertaken to determine the effect of cultivars and seed ratio in chickpea-mustard intercropping system on the severity of botrytis grey mold. Three chickpea varieties Abarodhi, KGP59 and ICCCV 97207 were intercropped with Bikash variety of mustard in different combinations. These two crops were grown at RARS, Khajura in three replications in 2012 at the ratio of sole chickpea, 3.1 ICCV97207.Bikash, 3.1 KPG-59.Bikash, 2.1 KPG59.Bikash, 2.1 ICCV-97207.Bikash, 2.2 ICCV97207.Bikash, 2.2 KPG-59.Bikash, 1.2 ICCV97207.Bikash, and 1.2 KPG 59.Bikash. Among the three tested varieties, highest disease score and AUDPC was recorded in Abarodhi (7.00, 0.83), followed by KPG59 (6.444, 0.79), and lowest in ICCV97207 (4.77, 0.58). Similarly in sole cropping, highest yield per plant was found in KPG59 (5.47g), followed by ICCCV9720 (4.46 g) and Abarodhi (3.46 g). Among the tested intercropping system, lowest disease incidence was recorded in 1.2 ICCV97207. Bikas followed by 1.2 KPG59. Bikash. From this research, it can be suggested that intercropping chickpea with mustard can significantly reduce BG of chickpea and thus it could be developed into an environment-friendly cropping system for BG control in chickpea fields. The combination, in which disease incidence was lowest, can be replicated in the areas where BG is a major constraint in chickpea production.

Key words : cicer arietinum, Botrytis cinerea, seed ratio, disease severity, and AUDPC

Introduction

Chickpea (Cicer arietinum L.) is one of the most important pulse crops of Nepal. The area and production of chickpea has been declining since last decade. According to ABPSD (2012), the area of chickpea was reduced from 14,308 ha to 9124 ha and production from 12,148 to 8,130 t from 2001 to 2010. The main cause of this decline is the flower drop and no pod formation problem (Chaurasiya and Joshi, 2004). Flower drop is mainly attributed to the attack of botrytis grey mold (Botrytis cinera Pers Ex.Fr) (Chaurasiya and Joshi, 2004). However, some workers also indicated that flower drop occurs due to the deficiency of boron, which cause to abort chickpea flowers (Shrivastav et al. 1996).

Botrytis gray mold (BG) caused by Botrytis cinerea Pers. ex. Fr., appeared as one of the most devastating diseases of chickpea, which may cause 100% yield loss. This disease was first reported in 1981 in Bangladesh (Ahmed et al, 1981) and now become the second largest problem of chickpea production after Ascochtyta blight around the globe (Nene et al., 1996). The disease severity increases and complete yield loss may occur in those years, in which winter is extensively wet and humid (Reddy et al., 1988; Pande et al., 2002). This disease is seed, soil and air borne.
Preventive measures, such as low seed rate, chemical spray, wider row spacing helps to reduce the
disease. Beside them the use of resistance varieties is most economical way of controlling the
disease. However, most of the varieties grown by farmers are susceptible to this disease. Varietal
screening to identify sources of BG resistance was initiated in 1984 in Nepal. However, changes in
disease reaction of several chickpea lines over seasons and location have made the breeding task for
botrytis resistance difficult (Karki et. al. 1989). The level of resistance/ tolerance is very low in the
identified genotypes, and the chemical control of the disease in not economical. Therefore, the
control of this disease through holistic approach of agronomical manipulations and use of resistance
genotype was considered appropriate. Researchers claimed that resistant cultivars and intercropping
offer the best solution to control the disease. Therefore, the focus of this study is to assess the
response of intercropping and varieties in minimizing the BG infestation in mid western Terai of
Nepal.

Materials and methods

A field experiment was carried out at Regional Agricultural Research Station, Khajura in 2012/13 to
find out the suitable intercropping system for higher profitability by managing BG below the
economic threshold level. The purpose of this experiment was also to find out the response of
different pipeline varieties on this devastating disease. Randomized complete block design (RCBD)
was used in this experiment. Three varieties of chickpea; Abarodhi, KPG 59 and ICCV97207 were
intercropped with Bikash variety of Toria in plot size of 5m × 3m. Treatment combinations in the
experiment were; Sole KPG59, Sole ICCV97207, Sole Abrodhi, 3.1 row ratio of ICCV97207 and
Bikash, 3.1 row ratio of KPG-59 and Bikash, 2.1 row ratio of KPG 59 and Bikash, 2.1 row ratio of
ICCV-97207 and Bikash, 2.2 row ratio of ICCV97207 and Bikash, 2.2 row ratio of KPG-59 and
Bikash, 1.2 row ratio of ICCV97207 and Bikash and 1.2 row ratio of KPG 59 and Bikash. This
experiment was carried out in three replications. Recommended fertilizer dose @ 20.40.20 kg NPK
per hectare was applied in this experiment. Row and plant spacing was 40cm × 10 cm.

RARS, Nepalgunj is located at 28° 06’ north latitude and 81° 37’ east longitude. The altitude of
research site is 181 meters above mean sea level. Average annual rainfall of the station is 1000-1500
mm. The average maximum and minimum temperature at the station is 46°C and 5.4°C respectively.
The relative humidity of this place ranges from 27 to 94%. The soil of the experimental plot was
sandy to silty loam, poor in organic carbon and available nitrogen, but medium in available
phosphorus and potassium. The soil pH varies from 7.2-7.5.

Botrytis gray mold of chickpea was scored on a 1-9 scoring scale as described by Singh (1999). The
interpretation of the scales was as follows. 1 = immune or Asymptomatic (I), 2 -3 = highly resistant
(HR), 4-5 = resistant (R), 6-7 = susceptible (S) and 8-9 = highly susceptible (HS). After the
appearance of the disease, it was scored three times at one week interval on whole plot basis. Area
under the disease progress curve (AUDPC) was calculated by the method used earlier by Shaner and
Finney (1977). Data analysis was done in Microsoft Excel (2007) and MSTAT-C (1986). Data
were subjected to analysis of variance (ANOVA) tests. When significant differences were found,
means were separated and assessed using Duncan's Multiple Range Test (DMRT). AUDPC was
regressed against grain yield (Gomez and Gomez, 1984).
Results and discussion

Yield per plant, average disease score of three consecutive dates 18 March, 26 March, and 4 April 2013, and AUDPC were recorded from the treatments of chickpea and mustard intercropping. The recorded data are presented in Table 1.

Table 1. Yield per plant, average score of three different dates and AUDPC of BG in chickpea in different combinations of chickpea - mustard intercropping at RARS, Khajura in 2012/13

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield per plant (g)</th>
<th>Score† (0-9 Scale)</th>
<th>AUDPC†† at March 26</th>
<th>AUDPC at April 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole KPG59</td>
<td>5.47abc</td>
<td>6.444ab</td>
<td>0.79ab</td>
<td>0.90ab</td>
</tr>
<tr>
<td>Sole ICCV97207</td>
<td>4.46bcd</td>
<td>4.77abc</td>
<td>0.58abc</td>
<td>0.66ab</td>
</tr>
<tr>
<td>Sole Abarodhi</td>
<td>3.46cd</td>
<td>7.00a</td>
<td>0.83a</td>
<td>1.04a</td>
</tr>
<tr>
<td>3.1 ICCV97207.Bikash</td>
<td>5.98abc</td>
<td>4.11abc</td>
<td>0.47abc</td>
<td>0.57ab</td>
</tr>
<tr>
<td>3.1 KPG-59.Bikash</td>
<td>3.93bcd</td>
<td>5.66abc</td>
<td>0.68abc</td>
<td>0.80ab</td>
</tr>
<tr>
<td>2.1 KPG 59.Bikash</td>
<td>5.77abc</td>
<td>5.22abc</td>
<td>0.64abc</td>
<td>0.66ab</td>
</tr>
<tr>
<td>2.1 ICCV-97207.Bikash</td>
<td>7.50ab</td>
<td>4.44abc</td>
<td>0.56abc</td>
<td>0.64ab</td>
</tr>
<tr>
<td>2.2 ICCV97207.Bikash</td>
<td>4.782abcd</td>
<td>3.88abc</td>
<td>0.50abc</td>
<td>0.45b</td>
</tr>
<tr>
<td>2.2 KPG-59.Bikash</td>
<td>4.67bcd</td>
<td>4.66abc</td>
<td>0.54abc</td>
<td>0.61ab</td>
</tr>
<tr>
<td>1.2 ICCV97207.Bikash</td>
<td>8.299a</td>
<td>3.00c</td>
<td>0.33c</td>
<td>0.40b</td>
</tr>
<tr>
<td>1.2 KPG 59.Bikash</td>
<td>5.71abc</td>
<td>3.11bc</td>
<td>0.37bc</td>
<td>0.42b</td>
</tr>
<tr>
<td>LSD</td>
<td>3.17*</td>
<td>2.99*</td>
<td>0.39*</td>
<td>0.48*</td>
</tr>
<tr>
<td>SEM=</td>
<td>1.03</td>
<td>0.97</td>
<td>0.12</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Note. Means within the column followed by the same are not significantly different at 5% level of significance by DMRT. SEM = Standard Error of Mean, LSD = Least Significant Difference, †Averages disease scores of three consecutive dates March, 18, March 26 and April 4, 2013. †† Area under Disease Progressive Curve.

Among the tested three varieties highest disease score and AUDPC was recorded in Abarodhi (7.00, 0.83), followed by KPG59 (6.444, 0.79), and lowest in ICCV97207 (4.77, 0.58). Similarly in sole cropping, highest yield per plant was found in KPG59 (5.47g), followed by ICCV9720 (4.46 g) and Abarodhi (3.46 g). Among the tested intercropping system, lowest disease incidence was recorded in 1.2 ICCV97207. Bikas, followed by 1.2 KPG59. Bikash. Out of all these treatments, highest yield of chickpea per plant was obtained from 1.2 ICCV97207. Bikas which was followed by 2.1 ICCV97207. Biaksh.

The results showed that ICCV97207 is comparatively disease resistant in all combinations of chickpea – mustard intercropping. Lowest disease incidence in low seed ratio of chickpea in chickpea mustard intercropping revealed that there is a good potential of growing chickpea intercropped with mustard where BG is major problem.

The response of different varieties with BG was studied by different researchers in the past. Five chickpea lines were found resistant and thirteen moderately resistant among the tested 2505 lines in growth chamber in 1992-1995 by Singh (1997). Similarly, different response of chickpea varieties with BG was also recorded by Hossain et al. (1997) and Pande (1998). The findings of the present
study revealed that the tested chickpea genotypes showed different types of reaction to BG under field condition. Reddy et al. (1993) reported that Chickpea genotypes with erect and compact growth habit had less BG in comparison to genotypes with bushy and spreading growth habit. The less incidence of BG on compact plant type is attributed to the differences in micro-climatic conditions.

Similarly, low BG incidence in intercropping as compared to sole cropping was due to wider spacing, which reduces humidity in the plant canopy, made by the harvest of mustard crop before the flowering of chickpea. High yield per plant in intercropping as compared to sole cropping is due to the low disease incidence as well as wider spacing and better opportunity to utilize soil moisture and solar radiation. The better yield per plant and lower BG incidence in intercropping system than sole cropping was supported by different researchers in the past. Moore and Ryley (2011) suggested adopting intercropping system to manage the BG in farmers’ field. Their suggestion is based on the principle that wider row spacing increases air movement and reduces humidity inside the crop canopy. This reduces the number and duration of infection events of Botrytis. Bakr, et al. (1997) reported that bushy and dense canopy resulting from close spacing and spreading type of plants increases humidity and favors the development of BG.

The results of research conducted in the past coincide and contradict with the result of this research. Reddy et al. (1993) reported that when chickpea was intercropped with linseed in Nepal, a marginal increase in chickpea grain yield was obtained because of low BG incidence and the linseed yield was bonus. However, in contrast to the result of this study Karki et al.(1993) reported no significant difference in BG incidence in sole or intercropping with mustard in Nepal. Bakr et al (1993) reported that chickpea intercropped with linseed showed a reduced incidence of BG in Bangladesh. The lower disease incidence in intercropping system might be due to the creation of wide spacing and low humidity in the plant canopy from the harvest of linseed during main disease attacking period. Chickpea appears to be most susceptible to infection at the flowering stage (Saxena and Johansen 1997). It can be concluded from these discussions that chickpea intercropped with other crops is an integrated management of BG.

**Relationship of yield with other traits**

The relationship between yield per plant with plant population, AUDPC and disease scores were worked out for chickpea in chickpea mustard intercropping system. The correlation between plant population, yield per plant, disease average score and average AUDPC of botrytis grey mold is presented in Table 2.

It is evident from the table that there was significant positive correlation between average BG scores and AUDPC, whereas negative correlation between yield per plant and plant population. Similarly, positive correlation was observed when plant population was regressed against the average disease scores of the BG. It was indicated that 88% of disease score was contributed by plant population while remaining 12% was contributed by other factors. Similarly, significantly negative correlation was observed between yield per plant and area under disease progress curve. However, only 21% variation in the grain yield of chick pea was due to variation in AUDPC under Khajura condition for chickpea mustard intercropping system. Rest of the variation in grain yield was attributed by other factors.
Table 2. Correlation between plant population, yield per plant, average score and average AUDPC of botrytis grey mold in chickpea in different combinations of mustard – chickpea intercropping system at RARS, Khajura in 2012-13

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Plant Population</th>
<th>Yield per plant</th>
<th>Average score</th>
<th>Av AUDPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Population</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield per plant</td>
<td>-0.154</td>
<td></td>
<td>-0.223</td>
<td></td>
</tr>
<tr>
<td>Average score</td>
<td>0.628**</td>
<td>-0.223</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Av AUDPC</td>
<td>0.605**</td>
<td>-0.246</td>
<td>0.992**</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed).

Results of research works conducted in the past are available to compare the findings of this research. Regression analysis was carried out between plant population, yield per plant, average disease score, and average AUDPC and the result of this analysis is presented in Table 3. Khan et al (2010) confirmed that the chick pea yield was greatly influenced by BG score and BG score was influenced by plant population. They found r value 0.73 when chickpea yield regressed against BG score.

Due to an increase in the relative humidity in microclimate within the crop canopy, disease epidemics occur. Singh (1997) showed that the disease increased significantly at high plant population under a dense crop canopy.

Researchers in the past suggested that close correlation between pant density and BG severity is caused by increased relative humidity and leaf wetness in chickpea (Tripathi and Rathi 1992; Butler 1993; Pande et al. 2002).

Table 3. Regression between plant population, yield per plant, average score and Av AUDPC of botrytis grey mold in chickpea in different combination of mustard – chick pea intercropping system at RARS, Khajura in 2012-13

<table>
<thead>
<tr>
<th>Regression</th>
<th>Equations ((Y = a + bx))</th>
<th>(r^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease score against plant population</td>
<td>(y = 0.031x + 0.586)</td>
<td>0.786**</td>
</tr>
<tr>
<td>Yield per plant (g) and Area under disease progressive curve</td>
<td>(y = -0.008x + 0.603)</td>
<td>0.046</td>
</tr>
<tr>
<td>Yield per plant (g) and average score</td>
<td>(y = -0.886x + 9.704)</td>
<td>0.453</td>
</tr>
</tbody>
</table>

The findings of this study has been supported by Kandel and Yadav (2008), Pande et al. (2006), Hossain et al. (1997), Bakr, et al. (1997), Butler (1993), Singh and Kapoor (1984), who reported that the chickpea line differed significantly with respect to agronomic traits and yield parameters. Khan (1991), Bakr and Ahmed (1992), Pande and Rao (2000) reported yield reduction of chickpea due to Botrytis gray mold. They recorded yield reduction of chickpea increased with the increasing of Botrytis gray mold disease severity.

Comparing with monoculture, carefully selected intercropping systems are favorable to control diseases without chemicals (Gómez-Rodríguez et al., 2003). It is suitable to be adopted in developing countries, and also has received attention as an approach to sustainable agriculture.
(Yu, 1999). The scarcity of genetically resistant resources has brought even more interest in the use of intercropping as a tool for crop disease management (Fernández-Aparicio et al., 2010). There have been many reports about intercropping systems which could suppress crop diseases. Yu (1999) found that intercropping with Chinese chive greatly inhibited the occurrence of bacterial wilt in tomato. Gómez-Rodríguez et al. (2003) documented that intercropping with marigold induced a significant reduction in tomato early blight caused by Alternaria solani. Zewde et al. (2007) recorded that garlic intercropped with Brassica spp. could also alleviate white rot of garlic. Ren et al. (2008) addressed that watermelon intercropped with rice in pot experiments could control Fusarium wilt in watermelon. Abdel-Monaim and Abo-Elyousr (2012) also documented that intercropping cumin, anise, onion and garlic could decrease the damping-off and root rot diseases of lentil significantly. Similar to those reports the results presented here demonstrated that chickpea mustard intercropping could suppress BG of chickpea.

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