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CHARACTERISTICS ASSOCIATED WITH OUT CROSSING IN A SHORT DURATION IMPROVED RICE (*Oryza sativa* L) VARIETY AT307

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ABSTRACT

Rice is considered as self-pollinated crop but out-crossing is possible. At307 is a high yielding, 90d variety developed at the Rice Research Station, Ambalantota, Sri Lanka possessing good attributes to be recommended as a commercial variety in Sri Lanka. It contains both Indica and Japonica germplasms. At307 has failed to pass the seed certification several times due to lack of its genetic purity perhaps due to out-crossing nature, or mechanical mixing. Therefore the present study was conducted to investigate the characteristics associated with out-crossing of At307. Comparison was done with Bg300, Bg304, At303 and At306 improved 90d rice varieties at Ambalantota rice research station during the Yala season, 2010. Out crossing mainly depends on flowering behavior, floral characteristics of male and female parts and variation in environmental factors. Varietal differences were found to be significant at 5% probability level for spikelet open angle. But spikelet open duration, numbers of spikelet per panicle (NS/P), stigma exsertion percentage, flowering period of plant, culm length), panicle length. Flowering period of panicle, angle of flag leaf, length of flag leaf and width of flag leaf were not significantly different among five selected rice varieties. Out-crossing associated characters of At307 were normal except spikelet opening angle. Increased exposes the stigma more to alien pollens resulting emerges off-types in future generation of At307.

Key words: Out- crossing, *Oryza sativa.* spikelet opening angle, At307

INTRODUCTION

Sri Lanka has achieved remarkable progress in rice yield improvement with the introduction of new improved rice varieties developed at the rice research stations at Batalgoda (Bg), Bombuwala (Bw), Ambalantota (At) and Labuduwa (Ld). Main objectives of rice research station at Ambalantota in Sri Lanka has been to develop short-age red rice, resistant to salinity, high yields and increase quality of rice grain and resistant to pest and disease.

It has already developed a number of rice varieties like At303, At353, At354, At401, At402, At405, At362, At306, At307 and At308. At307 is a high yielding 90d rice variety (pedigree- Bg2225-1 and Bg96-3298) which was released in 2005 and recommended for general cultivation. It has a high yield potential (8t/ha) and is resistant to Brown planthopper, Gall Midge, Bacterial Leaf Blight and Blast. The plant has a sturdy culm. At307 has failed seed certification in breeder seed, certified seed, foundation seed and register seed stages in several times due to emerging off-types which can be out-crossing, genetic purity problem or mechanical error.

Though rice is a 99% self-pollinated crop it has been observed to have out-crossing potential up to 6 - 8% in some varieties under certain conditions (Sahadevan and Namboodiri 1963). Crossing depends on flowering behavior, floral characteristics of male and female parts and variation in environmental factors. Present experiment was conducted to study the out-crossing associated characteristics of At307 with other improved 90d rice varieties (Bg300, Bg304, At303 and At306).

MATERIALS AND METHODS

The experiment was carried out at the Rice Research Station, Ambalantota from May to September in 2010. At307, Bg300, Bg304, At303 and At306 90d varieties were selected to test out-crossing associated characters under local

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condition. Cultural practices were done according to the recommendation of the Department of Agriculture. Associated out-crossing characteristics were measured at heading stage to flowering stage. The measurements were taken as follows; Culm Length (cm), Panicle length (cm), Flag leaf length (cm), Flag leaf width (cm), Flag leaf angle (degree), Duration of spikelet opening (min), Spikelet opening angle (^{o}), Panicle opening duration (days), Flowering period of plant (hr) , Numbers of spikelets per panicle, Stigma exertion Percentage (Percentage of stigma come out when spikelet closing)

$$= \frac{\text{Spikelets of stigma exserted}}{\text{Total spikelets in panicle}} \times 100$$

Randomized Complete Block Design (RCBD) with five replicates was used. Treatments were randomized using a random table. Twenty five pots were used for experiment with four plants per one pot. Variance was done at the 0.05 significant levels by using SAS package (v6.12) (SAS Institute, Cary NC, 1995).

RESULTS AND DISCUSSION

One hundred rice plants belong to five varieties were arranged in the research field at Rice Research Station, Ambalantota, Sri Lanka. All management practices were conducted according to recommendations of the Department of Agriculture from seed germination to flowering.

Significant out-crossing associated characters

Out-crossing potential is normally depended on some morphological and floral characteristics of rice plant (Virmani Sant, 1994). Spikelet open angle, Panicle length, Numbers of spikelet per panicle, Stigma exsertion percentage, Flowering period of panicle, Flowering period of plant, Spikelet open duration, Angle of flag leaf, Length of flag leaf, Width of flag leaf and Culm length of selected five rice varieties were tested. Varietal differences were found to be significant at 5% probability level for some of these characteristics of five selected rice varieties.

Spikelet open angle (SOA) has made a significant influence for out-crossing in rice plant under local condition. Higher out-crossing rate was always associated with higher Spikelet open angle due to ability of shedding high amount of pollen grains. Abesekara et al, 2003 also reported that SOA highly influence on out-crossing rate of Cytoplasm Male Sterile (CMS) line under local condition. At307 has significantly higher SOA than other four varieties (Table 1). So, out-crossing potential can be increased in At307 than other varieties due to higher SOA.

Spikelet open duration (SOD) is also important character to increase out- crossing in rice plant. It has been reported by Abesekara et al, 2003 under local condition in Cytoplasmic male sterile line. And also Namai, 1987 has been found that higher SOD enhance out-crossing rate in rice plant. When increasing SOD of spikelet environmental pollen shedding period was also increased and then out-crossing can be occurred in rice varieties. There are no significant differences among SOD of At307, Bg300, Bg304 and At303 (Table 1). Though At306 showed higher SOD value it has not reported out-crossing problem.

Virmani Sant, 1994 has reported higher stigma exsertion percentage (SE) influences out-crossing rate. However Abesekara et al, 2003 reported that stigma exsertion rate has no influence on out-crossing rate under local condition. When some variety consists with stigma exserted spikelets after closing lemma and palea, they can be crossed with pollen grains of other varieties. Generally, cultivated rice showed lower stigma exsertion rate compared to wild rice (Virmani Sant, 1994). Stigma exsertion percentage of At307 was not significantly higher from other varieties (Table 1). Although At306 and Bg304 have showed higher stigma exsertion percentage, they were not reported out-crossing problem.

Culm length is the other important plant character which also affecting natural out- crossing of rice. Abesekara *et al.* 2003 reported that variation in plant height has no influence on out-crossing rate under local condition. Bg300 and Bg304 showed significantly higher culm lengths compared of At307 (Fig 1 D). However these two varieties have not out-crossing problem in the field.

Higher total numbers of spikelet and panicle exsertion rate were associated with higher out -crossing rate in CMS line. Virmani Sant, 1994 and Abesekara et al, 2003 have also reported that was essential to attain high out-crossing rate. Both varieties, At307 and Bg300 have showed significantly higher numbers of spikelets per panicle (Fig. 1 E). However Bg300 has not reported out-crossing problem.

Flowering period of plant (FPOP) is important out-crossing related character of rice. When flowering period is longer, it influences out-crossing by exposing for pollen of other varieties in the environment. Similar results were reported Yadav et al, 2005 that blooming duration of panicles enhanced out-crossing ability of rice. However At307 did not show significantly higher FPOP in this study (Fig. 1F). At 306 showed higher FPOP than other four varieties.

Non significant out-crossing associated characters

Panicle length, Flowering period of panicle, Angle of flag leaf, Flag leaf length and flag leaf width of the varieties did not show any significant difference in this study. Chinese rice scientists have suggested that a small and horizontal flag leaf is useful to enhance the out-crossing rate compared to a long and erect flag leaf (Virmani Sant, 1994).

Other important characters for out-crossing

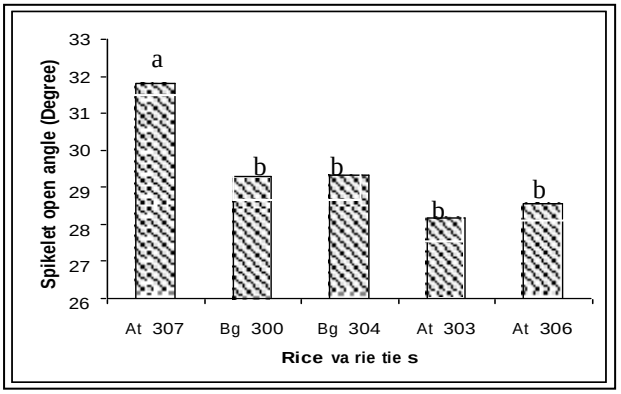
Floral traits of the seed parent which have been found to enhance out-crossing potential in rice include longer period of stigma receptivity and large and feathery stigma (Virmani Sant, 1994). Such varieties were found to have a larger number of protruding stigma. Therefore, Kato and Namai, 1987 considered that stigma protrusion contributes to a high natural out-crossing rate in rice. In addition Yadav et al, 2005 reported percentage of residual pollen and the duration of pollen viability enhanced out-crossing. Further Kato and Namai, 1987 have been found protruded stigma and higher residual pollens are improving out-crossing rate in tropical japonica rice. Therefore stigma characters should also be studied to understand reasons for out-crossing of At307.

Normally anther dehiscence and extrusion occur simultaneously so that the stigma of a flower receives pollen from the same flower in rice plant. However this process of At307 has not been studied. Rice pollen grains after shedding from the anther are comparatively short-lived and generally lose their viability within 5 min under ordinary conditions (Virmani Sant, 1994) in some exceptional cases a few pollen grains remain viable for 15 min (Koga et al, 1971). On the other hand, wild rice pollen grains have longevity of up to 9 min (Oka and Morishima, 1967). So pollen viability and stigma viability is the most important factors for out-crossing in rice plant. When considering lemma and palea opening time of At307 was observed later than other four varieties. When opening spikelets of At307, a large amount of pollen of other varieties spread to the environment that can be affected for out-crossing of At307. Not only morphological and floral characters, but also environmental factors have significant role for out-crossing. Virmani Sant, 1994 mentioned that temperature, relative humidity, light intensity and wind velocity are influencing natural out-crossing in rice.

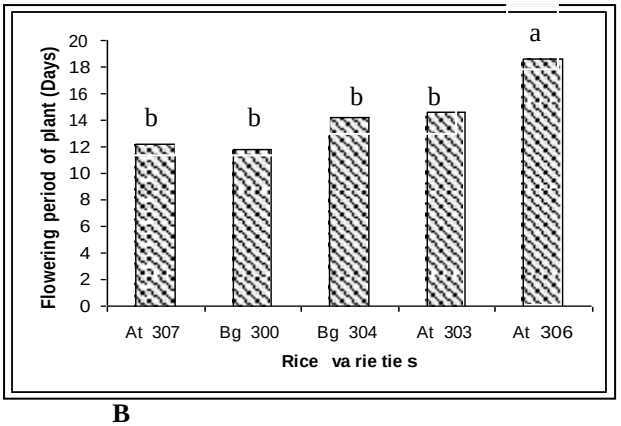
CONCLUSION

Out-crossing associated characters of At307

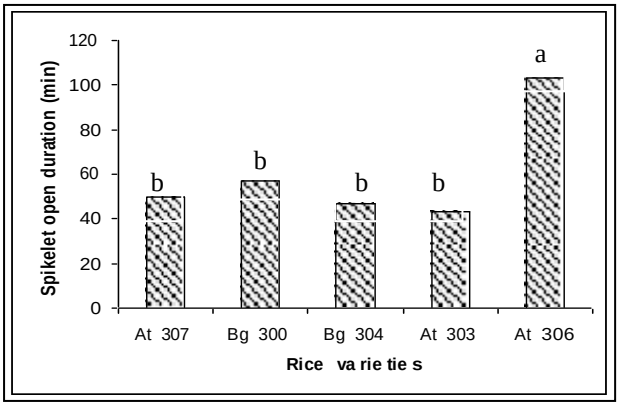
are in normal range except spikelet opening angle (SOA). Increased SOA exposes the stigma more to alien pollens resulting of emerging off-types in future generation of At307. At307 is the highest yielding 90d rice variety which produces only panicle bearings tillers. If At 307 cultivates in isolated fields, it has a good potential to overcome the out-crossing seed paddy production. At307 may be a potential variety for out-crossing to use in hybrid rice development.



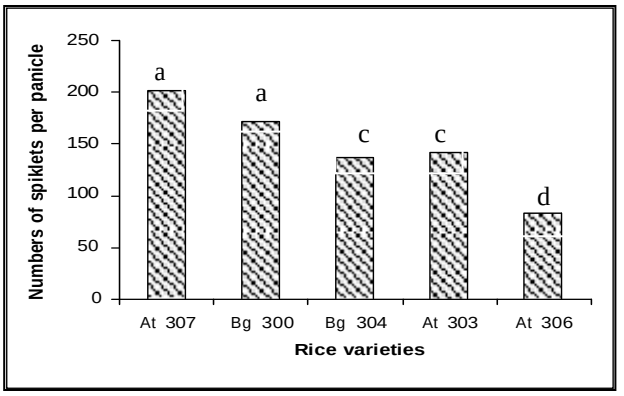
A



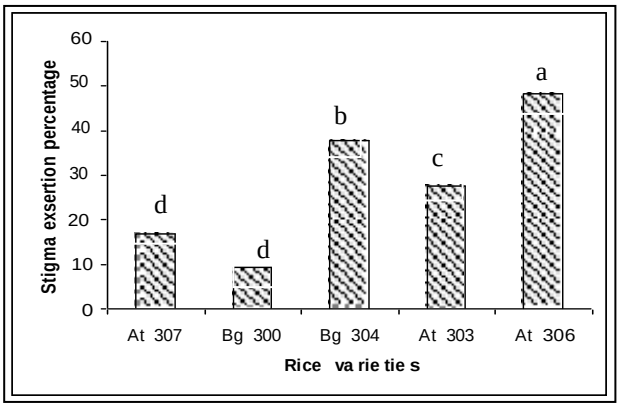
B



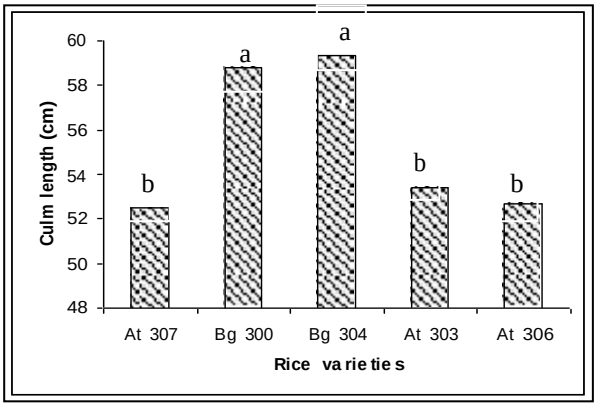
C



D



E



F

Fig. 1: Out-crossing associated characters of the rice varieties
(Means fallowed by the same lower case letters in each bar are not significantly different at 5% level Duncan's Multiple Range Test)

Authors' contributions

KAPA - Carried out the field experiments, participated in the design of the study, data collection and drafted the manuscript. DN - Participated in the design of the study, per-

formed the statistical analysis and writing the manuscript. PBD - Conceived the study, participated in the design and coordination of activities, collaborated in obtaining funds for the study; SSGJN- Participated in the design of the study and statistical analysis.

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